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THE

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AND

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WITH THE

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B. J. HARRINGTON, B. A., PH. D.
EDITOR.

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☞ The Editor of this Journal is responsible only for such communications as bear his name or initials.

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THE

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ANNUAL ADDRESS OF THE PRESIDENT OF THE NATURAL HISTORY SOCIETY OF MONTREAL, PRINCIPAL DAWSON, L.L.D., F.R.S., *May*, 1872.

As the Society has done me the honor to elect me twice in succession to the office of President, and as my address of last year was occupied almost entirely with local details, I may be permitted on the present occasion to direct your attention in the first place to some general topics of scientific interest, and merely to notice our own more special work in the end of this address. From the many subjects to which your attention and that of kindred Societies has been called in the past year, I may select the following as deserving our attention :—(1) The present aspect of inquiries as to the introduction of genera and species in geological time. (2) The growth of our knowledge of the Primordial and Laurentian rocks and their fossils. (3) The questions relating to the so-called Glacial Period.

There can be no doubt that the theory of evolution, more especially that phase of it which is advocated by Darwin, has greatly extended its influence, especially among young English and American naturalists, within the few past years. We now constantly see reference made to these theories, as if they were established principles, applicable without question to the explanation of observed facts, while classifications notoriously based on these views, and in themselves untrue to nature, have gained currency in popular articles and even in text-books. In this way young people are being trained to be evolutionists without being aware of it, and will come to regard nature wholly through this medium. So strong is this tendency, more especially in England, that there is reason to fear that natural history will be prostituted to the service of a shallow philosophy, and that our old Baconian mode of viewing nature will be quite reversed, so that instead of studying facts in order to arrive at general principles, we shall return to the mediæval plan of setting up dogmas based on authority only, or on metaphysical considerations of the most flimsy character, and forcibly twisting nature into conformity with their requirements. Thus "advanced" views in science lend themselves to the destruction of science, and to a return to semi-barbarism.

In these circumstances, the only resource of the true naturalist is an appeal to the careful study of groups of animals and plants in their succession in geological time. I have, myself, endeavoured to apply this test in my recent report on the Devonian and Silurian flora of Canada, and have shown that the succession of Devonian and Carboniferous plants does not seem explicable on the theory of derivation. Still more recently, in a memoir on the Post-pliocene deposits of Canada, now in course of publication in the *Canadian Naturalist*. I have by a close and detailed comparison of the numerous species of shells found embedded in our clays and gravels, with those living in the Gulf of St. Lawrence and on the coasts of Labrador and Greenland, shown, that it is impossible to suppose that any changes of the nature of evolution were in progress; but on the contrary, that all these species have remained the same, even in their varietal changes, from the post-pliocene period until now. Thus the inference is that these species must have been introduced in some abrupt manner, and that their variations have been within narrow limits and not progressive. This is the more remarkable, since great changes of level and of climate have occurred, and many species have been obliged to change their geographical distribution, but have not been forced to vary more widely than in the Post-pliocene period itself.

Facts of this kind will attract little attention in comparison with the bold and attractive speculations of men who can launch their opinions from the vantage ground of London journals; but their gradual accumulation must some day sweep away the fabric of evolution, and restore our English science to the domain of common sense and sound induction. Fortunately also, there are workers in this field beyond the limits of the English-speaking world. As an eminent example, we may refer to Joachim Barrande, the illustrious palæontologist of Bohemia, and the greatest authority on the wonderful fauna of his own primordial rocks. In his recent memoir on those ancient and curious crustaceans, the Trilobites, published in advance of the supplement to vol. 1st of the Silurian system of Bohemia, he deals a most damaging blow at the theory of evolution, showing conclusively that no such progressive development is reconcileable with the facts presented by the primordial fauna. The Trilobites are very well adapted to such an investigation. They constitute a well marked group of animals trenchantly separated from all others. They extend through the whole enormous length of the Palæozoic period, and are represented by numerous genera and species. They ceased altogether at an early period of the earth's geological history, so that their account with nature has been closed, and we are in a condition to sum it up and strike the balance of profit and loss. Barrande, in an elaborate essay of 282 pages, brings to bear on the history of these creatures, his whole vast stores of information, in a manner most conclusive in its refutation of theories of progressive development.

It would be impossible here to give an adequate summary of his facts and reasoning. A mere example must suffice. In the earlier part of the memoir he takes up the modifications of the head, the thorax and the pygidium or tail piece of the Trilobites in geological time, showing that numerous and remarkable as these modifications are, in structure, in form and in ornamentation, no law of development can be traced in them. For example, in the number of segments or joints of the thorax, we find some Trilobites with only one to four segments, others with as many as fourteen to twenty-six, while a great many species have medium or intervening numbers. Now in the early primordial fauna the prevalent Trilobites are at the extremes, some with very few segments, as *Agnostus*, others with very many, as *Paradoxides*. The genera with the medium segments are more characteristic of the later faunas. There is thus no progression. If the evolutionist holds that the few-jointed forms are embryonic or more like to the young of the others, then on his theory they should have precedence, but they are contemporary with forms having the greatest number of joints, and Barrande shows that these last cannot be held to be less perfect than those with the medium numbers. Further, as Barrande well shows, on the principle of survival of the fittest, the species with the medium number of joints are best fitted for the struggle of existence. But in that case the primordial Trilobites made a great mistake in passing at once from the few to the many segmented stage or *vice-versa*, and omitting the really profitable condition which lay between. In subsequent times they were thus obliged to undergo a retrogade evolution, in order to repair the error caused by the want of foresight or precipitation of their earlier days. But like other cases of late repentance, theirs seems not to have quite repaired the evils incurred; for it was after they had fully attained the golden mean that they failed in the struggle, and finally became extinct. "Thus the infallibility which these theories attribute to all the acts of matter organizing itself, is gravely compromised," and this attribute would appear not to reside in the trilobed tail, any more than according to some in the triple crown.

In the same manner, the palæontologist of Bohemia passes in review all the parts of the Trilobites, the succession of their species and genera in time, the parallel between them and the Cephalopods, and the relations of all this to the primordial fauna generally. Everywhere he meets with the same result; namely, that the appearance of new forms is sudden and unaccountable, and that there is no indication of a regular progression by derivation. He closes with the following somewhat satirical comparison, of which I give a free translation: "In the case of the planet Neptune, it appears that the theory of astronomy was wonderfully borne out by the actual facts as observed. This theory, therefore, is in harmony with the reality. On the contrary, we have seen that observation flatly contradicts all the indications of the theories of derivation with reference to the composition and first phases of the primordial fauna. In truth, the special study of each of the zoological elements of that fauna has shown that the anticipations of the theory are in complete discordance with the observed facts. These discordances are so complete and so marked that it almost seems as if they had been contrived on purpose to contradict all that these theories teach of the first appearance and primitive evolution of the forms of animal life."

This testimony is the more valuable, inasmuch as the annulose animals generally, and the Trilobites in particular, have recently been a favorite field for the speculations of our English evolutionists. The usual *argumentum ad ignorantiam* deduced from the imperfection of the geological record, will not avail against the facts cited by Barrande, unless it could be proved that we know the Trilobites only in the last stages of their decadence and that they existed as long before the Primordial, as this is before the Permian. Even this supposition, extravagent as it appears, would by no means remove all the difficulties.

Leaving this subject, we may turn for a little to the growth of our knowledge of the older faunas of the earth. A few years ago, when the last edition of Dana's Manual was published, the Potsdam Sandstone formed the base of the Palæozoic series in America, though Barrande in Bohemia and Salter and Hicks in Wales had disclosed lower horizons of life in those regions: now, in America, Palæozoic life descends almost if not quite as low as that of Europe. The researches of Mr. Murray in Newfoundland, together with the study of the fossils by Mr. Billings, have revealed a lower Potsdam, while Messrs Hartt and Matthew by their praiseworthy explorations of the rich primordial fauna of St. John, have enabled us to establish the "Acadian Group" on the horizon of the lower slate group of Jukes in Newfoundland, of the gold-bearing rocks of Nova Scotia, and of the slates of Braintree in Massachusetts.* Mr. Billings, I have reason to believe, will shortly be able to lead us to still greater depths, and as he indicated at a recent meeting of this Society, to introduce us to the fossils of Sir William Logan's Huronian group. It is thus clear that the student of American geology has to add a new or rather very old chapter to his studies of the older rock formations. In connection with this subject, Dr. Sterry Hunt has raised some new and startling questions as to the classification of all the old Metamorphic rocks of Eastern America, and has excited not a little of that controversy, which, like competition in trade, is the life of scientific progress. Dr. Hunt naturally attaches a very great importance to the mineral character of the more crystalline sediments; and in regions where fossils are wanting, and stratigraphy is obscure, he does well to claim precedence for his own special department of chemical geology; though those of us who have been accustomed to regard mineral character, as an uncertain guide, and to place our reliance on superposition and fossils, will hesitate to give our adhesion to his views, except so far as they may be established by these other criteria, while at the same time we must admit that Dr. Hunt has by his own labours immensely increased the value and importance of chemistry as an element in geological reasonings. Nor can there be any doubt that the promulgation of Dr. Hunt's views, in his address to the American Association last year, has given a new impulse to the study of this subject; and in the coming summer many skilled observers will be engaged in putting to those ancient, crumpled and mysterious rocks, which underlie or are associated with the fossiliferous rocks of Eastern America, the question, to what extent they will respond to the claims made on their behalf by Dr. Hunt. More especially we may look for much from the researches of Sir William Logan, who, released from the details of the business of the Survey, has been for some time applying his unrivalled skill as a stratigraphical geologist to the further elucidation of the intricacies of the structure of the Eastern Townships of the Province of Quebec; and whose matured results, whether in strict accordance with those deduced from the previous work of the Survey, or modified by his later researches, will be of the utmost value with reference to the structure of the whole of Eastern America.

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* Menevian of Salter, Etage D of Barrande.

The recent discoveries in the fossils of the primordial rocks have re-opened those discussions as to the terms Cambrian and Silurian which raged some years ago, between the late lamented Sir Roderick Murchison and his contemporary and survivor the venerable Sedgwick. Dr. Hunt has ably reviewed the history of this subject in the pages of the *Canadian Naturalist*, with the view of enquiring as to the best nomenclature for the present; and arrives at conclusions in harmony with those maintained by Sedgwick many years ago. I confess that I have myself long felt that the nomenclature introduced by the great authority of Sir Roderick and the English Survey, and followed somewhat too slavishly on this side of the Atlantic, requires a reform, of which indeed Sir C. Lyell has to some extent set the example in the latest edition of his elements. When Sir Roderick Murchison was preparing the last edition of his "Siluria," I had some correspondence with him on the subject, and ventured to urge that he should himself revise the classification of that work, wishing at the same time to make similar changes in my "Acadian Geology," the second edition of which was then in the press. But Sir Roderick was naturally unwilling to change the boundaries of that Siluria which he had conquered and over which he had reigned, and I contented myself at the time with affirming that the Silurian system, as held by Sir Roderick, really consists of two groups, which should have distinct names; but the question of the names I left to others. Dr. Hunt has now the credit of raising the question in a practical form, and I agree with him that the term Silurian should be restricted to the Upper Silurian of Sir Roderick, which constitutes a distinct period of the earth's history, equivalent to the Devonian or the Carboniferous. The Lower Silurian is really another distinct group, but to avoid multiplication of names, and as it formed the battle-ground of the Silurian and Cambrian controversy, I concur in the view that it may well have the name *Siluro-Cambrian*, while the name Cambrian or Primordial will remain for those great and important fossiliferous deposits extending downward from the Potsdam in America and the Tremadoc in England, and constituting an imperishable monument to the labours of Sedgwick and Barrande.

There remains one point still before leaving this subject. It is the gap between the fauna of the Primordial and that of the Laurentian—the latter still represented only by that Titan of foraminifers, *Eozöon Canadense.* Barrande refers to this gap in his memoir above mentioned; and I had hoped ere this time to have done something to bridge it over. I may here state in anticipation of the results of researches still incomplete, (1) That in rocks of Huronian age in Bavaria and probably also in Ontario, Eozoon has been found. (2) In the middle and Upper Cambrian we know as yet few limestones likely to contain such a fossil, but we have in Labrador species of *Archæocyathus*, one of which I have ascertained to be a calcareous chambered organism of the nature of a foraminifer; though there seems little doubt that others are, as Mr. Billings has shown, allied to sponges. (3) In the Cambro-Silurian, in the limestones of the Trenton group, animals of the type of Eozoon return in full force. The concentrically laminated fossils which sometimes form large masses in these limestones, and which are known as *Stromatopora*, are mostly of this nature, though it is true that fossils of the nature of corals have been included with them. In the Silurian proper, we have the similar if not identical forms known as

Coenostroma, and which according to Lindstrom, form masses in the shales and limestones of Gothland a yard or more in diameter. In all these fossils the skeleton consists of a series of calcareous layers connected with each other by pillars or wall-like processes. The layers are perforated with minute artifices, which are, however, less delicate and regular than in Eozoon, and have in the thickened parts of the walls, radiating tubes of the nature of the canals of Eozoon. (4) On a still higher horizon, that of the Devonian, these organisms abound, so that certain limestones of this age in Michigan contain, according to Winchell, masses sometimes twelve feet in length, and in one place constitute a bed of limestone twenty-five feet in thickness. A beautiful collection of these Devonian forms, recently shown to me by Mr. Rominger, of the State Survey of Michigan, who has worked out these fossils with great care, fully comfirms their foraminiferal affinities, and also shows that in some respects, these Devonian forms are intermediate between the Eozoon of the Laurentian and the *Parkeria* and *Loftusia* of the Greensand and Eocene. We thus learn that these gigantic representatives of one of the lowest forms of animal life have extended from the Laurentian, through the Huronian, Cambrian and following formations, down nearly to the close of the Palæozoic. I have no doubt, that when these successive forms are studied more minutely, they will show like the Trilobites, indications rather of successive creations than of evolution, though in creatures of so low organization the differences must be less marked. The point I now wish to insist on, is their continuance, from the Laurentian down to a comparatively modern geological period.

For the third topic referred to at the beginning of this address, I have reserved little space. In the memoir in the Journal of the Natural History Society already referred to, I have re-asserted and supported by many additional proofs that theory of the combined action of Icebergs and Glaciers in the production of our Canadian Boulder-clay and other superficial deposits, which, fortified by the great names of Lyell and Murchison, I have for many years maintained, in opposition to the views of the extreme glacialists. It is matter of gratification to me to find, in connection with this, that researches in other regions are rapidly tending to overthrow extreme views on the subject, and to restore this department of geological dynamics more nearly to the domain of ordinary existing causes. Whymper, Bonney, and other Alpine explorers, have ably supported in England, the conclusion which after a visit to Switzerland in 1865, I ventured to affirm here, that the erosive power of glaciers is very inconsiderable. The recent German expeditions have done much to remove the prevailing belief that Greenland is a modern example of a continent covered with a universal glacier. Mr. Milne Home, Mr. McIntosh, and others, have ably combated the prevalent notions of a general glacier in England and Scotland. Mr. James Geikie, a leading advocate of land glaciers, has been compelled to admit that marine beds are interstratified with the true boulder-clay of Scotland, and consequently to demand a succession of elevations and depressions in order to give any colour to the theory of a general glacier. The idea of glacial action as means of accounting for the drifts of central Europe and of Brazil seems to be generally abandoned. Lastly, in a recent number of Silliman, Prof. Dana has admitted the necessity, in order to account for land glaciation of the hills of New England, of supposing a mountain range or table land of at least 6,000 feet in height, to have existed between the St. Lawrence and Hudson's Bay, while in addition to the imaginary N. W. & S. E. glacier, flowing from this immense and improbable mass, there must have been a transverse glacier running beneath it up the valley of the St. Lawrence. Such demands amount, in my judgment, to a virtual abandonment of the theory of even very large local glaciers in America in the Post-pliocene period. Thus there are cheering indications that the world-enveloping glacier, which has so long spread its icy pall over the geology of the later Tertiary periods, is fast melting away before the sunshine of truth.

With the exception of that which relates to the Post-pliocene, the geology of Canada has hitherto had to deal only with the more ancient formations. Now, however, there opens up to us a vast field of mesozoic geology in the far west. Already the exploring parties of the Geological Survey are bringing the first fruits of this harvest. The first report of the survey on British Columbia and Vancouver Island is not yet published, but Mr. Selwyn has given us a sketch of his work and that of his indefatigable assistant, Mr. Richardson, in a most interesting and important communication to this Society, a communication which we hail as an earnest of the great things to be expected from the exploration of those great western territories of the Dominion, whose grand physical features of mountain and plain so excite the imagination, and whose structure and natural productions are so different from those of our eastern regions, and therefore so stimulating to our curiosity.

These explorations will, no doubt, serve not only to enrich the annals of science but also to disclose those sources of material wealth which will ere long attract large populations and capital to the Pacific Coast. In the meantime, perhaps, no features excite greater interest on the part of the geologist than the appearance of a comparatively highly altered condition in sediments of no great geological age, and the occurrence of coal in Vancouver Island, associated with animal fossils of Cretaceous date and with a flora composed of exogenous trees of very modern aspect.

In addition to the papers on which the above remarks have been based, we have had two interesting communications from Prof. Nicholson of Toronto, whom we welcome as a valuable addition to our band of workers. Dr. Hunt has contributed a paper on the structure of Mont Blanc; Mr. Billings has given us papers on the Fossils from the Huronian rocks, on the Taconic controversy, on the genus *Obolellina* and on new species of Palæozoic Fossils; Prof. Bailey has given us a paper on the previously little known geology of the Island of Grand Manan; and Mr. Matthew, one on the Surface Geology of New Brunswick. Dr. Anderson, of Quebec, has contributed a notice of a whale captured in the Gulf of St. Lawrence; Mr. Macfarlane has given us his views on the classification of crystalline rocks; Dr. Carpenter has directed our attention to the death-rate of Montreal; and Dr. Smallwood has reported on Meteorological Results for 1871.

I cannot conclude without referring to a new branch of scientific research undertaken by the Society in conjunction with the Department of Marine and Fisheries—that of dredging in the deeper and hitherto unexplored parts of the Gulf of St. Lawrence; and we have to congratulate ourselves on important scientific results obtained in a manner equally creditable to the Government, to the Society, and to its Scientific Curator, Mr. Whiteaves. A knowledge of the fauna of the Gulf has been obtained to a depth of 250 fathoms. Probably one hundred species have been added to the known inhabitants of our Canadian waters. Interesting facts have been obtained as to the distribution and food of fishes; and the attention of the Government of the Dominion has been awakened to the value of researches of this kind. It is hoped that they will be renewed in the approaching summer with larger means and with apparatus for ascertaining more correctly the temperature and composition of the water at great depths.

In conclusion, we have much reason to be satisfied with the measure of success which has attended our work in the past year, and to take courage for the future.

NOTES ON SOME RESULTS OF THE LAST SOLAR ECLIPSE.

By George Frederick Armstrong, M.A. C.E.,

Professor of Engineering and Applied Mechanics, McGill University.

The Solar Eclipse of the 12th of December, 1871, closed a series of such phenomena, presenting features of exceeding interest to science. Commencing in 1865, the Eclipses of that and, with one exception, the six succeeding years afforded opportunities, such as will not again occur for some few years to come, of investigating some problems in Solar Physics by the aid of spectroscopic analysis: many of them being of the first order of importance. It may, therefore, be useful to sum up briefly the results that have so far been obtained.

The untoward difficulties with which the expedition of December, 1870, was called upon to contend, and which partly arose from a hurried organization and partly from the more serious obstacle presented by unfavorable weather—the English suffering from both and the other observing parties from the latter cause only—were not, fortunately, encountered by the observers of the following year.

The principle path of the Moon's shadow during the last Eclipse, as was the case in some previous years, did not traverse any portions of either Europe or America, but was confined to Australia, Ceylon and India. Parties of observation were accordingly stationed on the Gulf of Carpentaria, at Trincomalee (Mr. Moseley's), at Bekul (Mr. Lockyer's party, with Col. Tennant, Mr. Davis, Capt. Maclear and Professor Respighi), at Avenashi

(Mr. Pogson's), at Sholoor (Mr. Jannsen's), at Jaffna and a few other places of less interest.

At the first named Station circumstances prevailed which were disastrous, as far as observation was concerned; at all the others, however, complete success attended the work undertaken.

The almost total failure, in the matter of trustworthy observations, of the Eclipse—mainly visible in Northern Africa, Sicily and Spain—of the preceding year had left physicists in a position of much doubt and perplexity as to a number of very grave questions of science. Those, therefore, who were interested in the solution of these problems were literally on tip-toe of expectation as to what the Eclipse of which we purpose to speak might reveal. And it is encouraging to know that the result has not been disappointing, and that we may now say that the questions that required an answer have received one, and that many differences of opinion among solar observers may thus be considered as finally decided and put at rest.

It is not our intention at this time to attempt anything more than a passing notice of a few points that are of chiefest interest, and upon which light has been thrown by the observational work of the late Eclipse; and among these will stand preeminent such observations as deal with the nature and origin of the Corona,—that sheeny mane of striated and radial structure which, during an Eclipse, surrounds and adorns the Sun's hidden disc, and whose dazzling brilliancy in its more immediate neighbourhood shades off, at a remoter distance, into a halo of silvery grey and hazy indefiniteness of vast dimensions.

Next in importance to these may, perhaps, be regarded those observations which have to do with the extent and position of the Sun's *chromatosphere* (Respighi)—that gaseous envelope, that is, to whose absorptive powers upon the emenations of the light-giving Photosphere is due the presence of the dark lines of Fraünhofer in the Solar Spectrum. And it may be as well to mention that the reason why so much curiosity centres in any spectroscopic observations that it may be possible to make of this envelope, *unassociated with any other of the Sun's surroundings*, is owing to the fact that its existence was first suggested by Professor Stokes, in 1849, on purely theoretical grounds, and was afterwards experimentally demonstrated in the reversal of the Sodium Spectrum by Kirchoff, but nevertheless its presence had not, before the two last eclipses, been, by actual observation, demonstrated.

Upon questions having reference to the Prominences and other immediate surroundings of the Sun—phenomena which can be as well, if not more easily investigated at other times—it is not our intention now to offer any remarks.

It may be said, then, that until the latter part of the year, 1870, the spectroscope had failed to disclose the typical spectrum of that absorbing envelope, now call the *chromatosphere.* But at the close of that year, Professor Young was successful in identifying it during the December Eclipse. It was known to be vaporous from its absorptive action, and might, therefore, be expected to yield a *discontinuous spectrum* of bright lines, corresponding to the dark lines in that of ordinary sun-light. It was suspected also, by Secchi and others, to be shallow in comparison of its associated envelopes. Then again, owing to the amount of diffused light present and the extremely small angle such an object as it was supposed to be would subtend at the earth's surface (not more than *two* or *three seconds*), it was seen to be almost impracticable to obtain any spectroscopic view of it during ordinary daylight. In addition to this, the attention of observers during the preceding Eclipses of the series had been turned to the investigation of what were then more important matters. Hence it was that the spectrum of this member of the Solar surroundings remained undetected until Professor Young, of Dartmouth—of whom, as well as of the other American observers, it is only right to say that the work done by them has universally borne the impress of unfailing care and thoroughness,—succeeded, when observing in Sicily, in obtaining its unassociated spectrum.

This discovery was thus reported by one of his fellow observers, Professor Langley:—"With the slit of the spectroscope placed "longtitudinally at the moment of observation, and for one or "two seconds later, the field of the instrument was filled with "bright lines. As far as could be judged during this brief "interval every non-atmospheric line of the Solar Spectrum "showed bright." He adds, "we seem to be justified in "assuming the probable existence of an envelope (*the chromatos-"phere*) surrounding the Photosphere, and beneath the Chromo-"sphere, usually so called, whose thickness must be limited to "two or three seconds of arc, (*from nine to fourteen hundred "miles*), and which gives a discontinuous spectrum consisting of "all, or nearly all, the Fraünhofer lines, showing them, that is, "*bright* on a dark ground."

Upon the trustworthiness of this discovery, which, let it be remembered, refers to December, 1870, much unreasonable doubt was thrown by some members of other observing parties that had been less fortunate in their operations. However, the time of waiting was not long, for an opportunity of testing its correctness was expected in the following year.

The Eclipse of 1871, the one, that is, with which we have particularly to deal, was of short duration; and Monsoon weather was, moreover, feared about the time of its occurrence. The sequel, however, showed that neither of these circumstances operated disadvantageously, for both Col. Tennant and Capt. Maclear, and perhaps Professor Respighi, who is somewhat doubtful of the exact meaning of what he saw, were rewarded with a fine spectroscopic view of the Chromatosphere itself, and found it to be in all respects similar to the one already described; and so these distinguished observers were, therefore, enabled fully to confirm the previous observation of Professor Young. It may be unnecessary to state that neither Mr. Lockyer nor Mr. Moseley were equally fortunate, since their failure can in no way detract from the weight of positive evidence obtained by others.

Thus then was a prediction, based originally on theory and experiment, borne out by direct observation, and the infallibility of true scientific method once again vindicated.

We must now turn our attention to the Corona and the facts which the late Eclipse has established as to its nature. The Corona consists essentially of two parts, of unequal extension and luminosity; the shallower and brighter next the Sun; the more extended and dimmer extending far beyond the outer margin of the former. It has been proposed to designate the smaller and brighter the *Corona* proper, and the dimmer and more extended portion the *Halo;* a distinction that we propose to observe in what follows.

Various theories have from time to time been propounded as to the nature and cause of the Coronal phenomena generally. One maintained that they are entirely of Solar origin; another that they are due to the effects of the Earth's atmosphere and have no objective existence; while a third attributed them to the effects of lunar diffraction or reflection. The Spectroscope, however, in the hands of Mr. Huggins, told us some time ago that the Moon has no atmosphere. This last theory, therefore, had to be abandoned, and the contest was consequently reduced to a choice between the two others that remained.

The principal questions then, pending at the time of the Eclipse of 1871, were somewhat as follows:—What order of Spectra do the Corona and Halo give? Are they of the same or of diverse orders, or are they blended? At what distance from the Sun's limb can a spectrum be obtained and where is the bounding line, if any, between the Corona proper and the Halo? Is the light of either or both polarised and, if so, how? And finally, what spectroscopic indications are there of the presence of an, as yet, *terrestrially unknown form of matter* in these wonderful solar appendages, if they be such?

To all these enquiries it is satisfactory to state that answers were forthcoming, and of such a kind as to put an end to speculation as to the coronal nature.

In order to make what is to follow clear, it may be proper here to mention that Angstrom in the year 1867, when spectroscopically examining the Aurora Borealis and Zodiacal light, found in both spectra a *bright green line*, of wave length = 5567, supposedto correspond with a *faint* line numbered 1474 on Kirchoff's scale, and grouped by him among the four or five hundred lines of Iron; but not as one of those that are *characteristic* of that metal. On one occasion when the sky was peculiarly phosphorescent, Angstrom detected this same line, not only in the Zodiacal light, but in all parts of the heavens; and on each occasion it was present *unassociated with any other lines of iron;* a fact that may be construed as indicating the presence of some new form of matter, hitherto *unknown*, inasmuch as the only appearance of this particular line with which we are terrestrially acquainted is as a *supposed but insignificant* member of the iron group. During the Eclipses of both 1869 and 1870, Professor Young announced that he had detected this same line in the Corona and Halo, and in a *bright* and characteristic form. And the matter to which this line is supposed to be due afterwards received the name of "1474– matter."

The import of this discovery, supposing it to be valid, cannot fail to be patent to the reader, for it reveals the existence of a new and mysterious form of matter, of which we had no previous conception, present alike in the Aurora, Zodiacal-light, Coronal appendages and even in the interstellar regions themselves; we may say indeed everywhere and all-pervading. What, we at once ask, is its nature and what its function in the economy of nature? But these are questions to which, as yet, we have no satisfactory reply.

The condition of our knowledge of the spectra of the Corona and Halo at the time of the eclipse of 1870, are well stated in Professor Young's summary. He considered that the spectrum of the Corona and Halo consisted of:—

1. "A continuous spectrum without lines, either bright or "dark. due to incandescent dust—that is, particles of solid or "liquid meteoric matter near the Sun."

2. "A true gaseous spectrum consisting of one (1474) or "more lines. which may arise from the vapour of the meteoric "dust, but more probably from a solar atmosphere through "which the meteoric particles move as foreign bodies."

3. "A true sunlight spectrum, *with its dark lines*, formed by "photospheric light reflected from the solar atmosphere and "meteoric dust. To this reflected sunlight is undoubtedly due "most of the Polarization."

4. "Another component spectrum that is due to the light re-"flected from the particles of our own atmosphere. This is a "mixture of the three already named, with the addition of the "chromosphere spectrum, for while at the middle of the eclipse "the air is wholly shielded from photospheric sunlight, it is of "course exposed to illumination from the prominences and upper "portions of the chromosphere."

5. "If there should be between us and the Moon at the mo-"ment of the Eclipse, any cloud of cosmical dust, the light re-"flected by this cloud would come in as a fifth element."

Such a spectrum, as will be seen, is, to use again Professor Young's words, "exceedingly complex."

The correctness of these views was, as has been previously hinted, fully established during the late Eclipse. And among the observations then made the chief place in importance must be given to those of Respighi and Janssen. The former, when observing, adopted the original method of Fraünhofer and placed the prism in front of the object glass, instead of in the position of the eye piece of his telescope; an arrangement whereby a series of overlapping coloured images of the observed object itself are formed, and not merely a number of coloured reproductions of the slit that is usually employed. M. Janssen on the other hand, while using the spectroscope in the place of the eye piece, did so without a slit;—as did also Mr. Lockyer, who observed at Bekul. The telescope employed by Janssen was specially adapted to ensure a very much increased illumination of the image in its field of view. This telescope, although its aperture was 14 inches, had a focal length of only 54 inches; a proportion calculated to produce images fourteen times as bright as in an ordinary instrument. His point of observation, Sholoor, in the Neilgherry Hills, also was at an unusual altitude.

What each of these physicists was successful in seeing may be best gathered from their own descriptions.

Respighi says, in speaking of the coloured zones visible in his instrument when examining the Corona and Halo, that there was "one in the red corresponding with the line C (Hydrogen); another in the green, probably coinciding with the line 1474 of Kirchoff's scale (the *unknown matter*), and the third in the blue, perhaps coinciding with F (Hydrogen). The green zone was the brightest, the most uniform and the best defined. The red zone was also very distinct and well defined, while the blue zone was faint and indistinct. The green zone was well defined at the summit, though less bright than at the base, its form was sensibly circular and its height about 6′ or 7′. The red zone exhibited the same form, and approximately the same height as the green, but its light was weaker and less uniform." He then goes on to say, "these coloured zones shone out upon a faintly illuminated ground without any marked trace of colour. If the Corona or Halo contained rays of any other colour, their intensity must have been so feeble that they were merged in the general illumination of the field."

M. Janssen states his experience thus: "The reasons," he says, "which militate in favour of an objective solar origin (i.e., of the coronal phenomena) acquire an invincible force when we examine the luminous elements of the phenomena. In fact the spectrum of the Corona (and Halo) has not shewn itself (in my telescope) continuous, as it has hitherto been formed, (i.e., by those observers, who differed from Professor Young in 1870), but remarkably complex. I have discovered in it the bright lines, though much enfeebled, of hydrogen gas, which forms the principal element of the prominences and sierra; the bright green line which has already been noted during the eclipses of 1869 and 1870, as well as some other fainter lines; and the dark lines of the ordinary solar spectrum, notably that of sodium. These dark lines are much more difficult to perceive. These facts prove the existence of

" matter in the sun's neighbourhood—matter revealing itself in " total eclipses, by phenomena of emission, absorption, and polari- " zation. But the discussion of the facts leads us yet further. " Besides the cosmical matter independent of the sun, which " must exist in the neighbourhood of that orb, the observations " demonstrate the existence of an atmosphere of excessive rarity, " mainly composed of hydrogen, extending far beyond the chro- " matosphere and protruberances, and fed from the very matter " of these—matter erupted with great violence, as we perceive " every day. The rarity of this atmosphere, at a certain distance " from the chromatosphere, must be excessive; so that its exist- " ence is not in disagreement with the passage of certain comets " near the sun."

Although Respighi was only able to detect this *coronal atmosphere*, which he and Janssen were the first fully to make out, at a distance of 7′ or 8′ (*about two hundred thousand miles*) from the Sun's disc, both Capt. Maclear and Capt. Tupman nevertheless succeeded in tracing it spectroscopically as well as by polariscopic means, as far as 45′ (*nearly a million and a quarter miles*); a distance from the Sun which is probably still very far within its true limits.

One more point of interest yet remains, and that is the evidence of the polariscope. A few words will suffice. During the Eclipse of the preceding year, Mr. Raynard and Mr. Pierce found the coronal atmosphere generally to be polarized radially. And this again was the case in Capt. Tupman's observations during the late Eclipse, when, as has just been said, he succeeded in detecting this peculiar state of the light, at a distance of over a million and a quarter miles from the margin of the Sun; showing that the Corona and Halo in all probability reflect solar light, as well as emit light of their own, and involving as a consequence the presence of *matter* in a region so remote from the Sun itself.

A word as to the labours of the Photographers will conclude these remarks.

It is gratifying to be able to say that, in spite of the brief duration of totality, seventeen good negatives were obtained, somewhat inferior, however, as showing the coronal extension, to those of Mr. Brother's Syracuse pictures of the preceding year, yet nevertheless, of great interest and value. Eight were taken at Bekul, three at Avenashi and six at Jaffna. Mr. Holiday in addition to these made some useful hand drawings also of the passing phenomena of the Eclipse.

IMPRESSIONS OF CUBA.

By G. F. Matthew.

Having been recommended several years ago to try a sea voyage for the benefit of my health, I accepted the invitation of some very kind friends to visit Cienfuegos, a town on the south side of Cuba. My voyage was made in the winter of 1866–67, and I remained two months and a half on the Island. The following pages contain a short description of such of the natural features of the country as still remain impressed on my memory, together with a few remarks upon its people, industries and vegetation.

We sailed from New York on Christmas Day, and after being buffeted about by contrary winds for a fortnight, at length entered the trade-wind region and sped onward toward the West Indies. On entering this zone of "N. E. Trades," the pale misty sky of the North Atlantic is at once exchanged for one of the clearest blue, and the ill defined horizon for one of the greatest distinctness; so that the voyager is no longer left in doubt as to the line where sky ends and sea begins.

The azure ocean in these latitudes has a fascination for one accustomed to the dull green hues of our northern seas, while the floating gulf-weed with its miniature world of living forms, and the new kinds of fishes—reflecting from their sides in metallic tints the color of the waters in which they find a home—are sights upon which the eye dwells with ever increasing pleasure.

With the charming weather which prevails on the southern coast of Cuba during the winter months, the voyager as he creeps along can thoroughly enjoy the ever-changing views presented by that magnificent range of mountains—the Sierra Maestra. This range extends along the coast from near Cape Maysi, the eastern extremity of the Island, to Cape Cruz, a distance of two hundred and fifty miles, and has many sharp peaks of great height. For long distances it rises boldly from the sea, presenting beetling cliffs several hundred feet high.

At the eastern and western ends of this elevated tract of land, walls of rock may be seen to extend for scores of miles along the mountain side. At the eastern end of the Island there are quite a number of them at different heights, and all seemingly quite horizontal. I suppose them to be old coral-reefs marking successive stages in the elevation of the land during the Pliocene and Post-pliocene periods. Mr. Sawkins, in his recently published *Geology of Jamaica*, speaks of an extensive limestone formation of the latter period in that Island, ascribing to it a thickness of 2,000 feet.

Coral walls similar in aspect to those just described, but at lower levels, fringe the coast of Cuba further westward; some are elevated a few hundred feet above the sea, while the tops of others are still washed by the ocean.

The Sierra Maestra has, among its higher mountains, peaks, which in height exceed any of the Appalachian or Laurentian Mountains of North America. They are directly upon the seaboard, and being 8,000 feet high, present a far more imposing spectacle than those of any range in Eastern North America. If one may judge from its jagged outline and steep sides, this range has been thrust up in comparatively recent geological times; and if the movement which resulted in its elevation were cotemporary with those acting upon the ridges thrown up in the western part of the Island, it probably received its present form about the close of the Miocene period. When we sailed by it, the whole southern side, with the exception of a very narrow strip along the shore, was of a uniform brown color. There was thus little to divert the eye from the thin wreaths of mist which could be seen to gather in the gorges among the higher crests, and which told so plainly the history of daily change in the temperature.

In the early part of the day they appeared at elevated points along the mountain, and gradually increased among the upper valleys, and on the shoulders of the hills as the day wore on; till at length they combined in one continuous cloud belt, which hid from view the greater part of the range. Sometimes they would extend more than half way down it sides; but in all cases the higher peaks peeped forth, or stood out boldly above the rolling sea of mist.

Every hour after mid-day added to the density and extent of the cloud-belt, till night came and hid it from view. Next morning the whole body of cloud had disappeared from the mountains, having been swept away to leeward during the night by the trade winds; but could still be discerned far off on the distant verge of the horizon in the direction of Jamaica. As soon as the hot sun made its power felt, and the wind drew in again off the sea, a new wreath of cloud began to gather along the side of the mountains, and increase as before.

After passing Cape Cruz we were driven rapidly along the chain of keys which extends thence nearly to Trinidad, where a spur from the central mountain chain comes down to the coast. The mountains here, though not nearly so high as those at the eastern end of the Island, stand out prominently above the general level of the land, when seen from the sea. They do not extend to Cienfuegos; but on approaching that harbor, a low ridge may be seen extending apparently without any break for a great distance along the shore. On coming close to the land this apparent continuity is interrupted by a slight, inconspicuous indentation, marked by a light-house; this is the opening into Xagua Bay, upon the north side of which stands the town of Cienfuegos. The passage into the bay is narrow and tortuous, but very deep: at a point about half-way in, where it makes a right angle, a fort has been erected to command the entrance to the harbour. The spot is very wild and picturesque; and, from its being on the line of an old highway through this part of the Island, it has received the name of *Passa-caballos* (Horse-ferry.) A very strong current runs past it, and the spot is a favourite fishing and bathing resort for the inhabitants of Cienfuegos. Steep ledges of coral and shell-rag—furnishing shelter and a home to delicate sea-weeds, crustaceans, thorny oysters and other molluscs—border both sides of the passage; and the same rocks stand up in steep, but not very high hills on each side. They are a part of the long, but narrow ridge of limestone, which, for many miles, divides Xagua Bay from the Caribbean Sea.

Judging from the fossils it contains and the light color of the rock it belongs to the white limestone formation (Post-pliocene) described by Sawkins as covering large areas in Jamaica. It is a barrier reef raised upon the older Miocene beds (seen further inland,) but is now elevated a hundred feet or more above the sea.

On the outside of the ridge, but near the passage leading into Xagua Bay, are some short sea-beaches, upon which numbers of shells are cast up by the waves, and are much worn by exposure to the surf.

Among those gathered here by Mr. R. M. Fowler and myself, Mr. Kreebs of Saint Thomas, W. I., recognized the following species:—

Murex coruncerui, Mart.
Strombus gigas,
S. pugilis,
Cassis, sp.
Fasciolaria Tuldyra,
Ranella Cubaniana, d'Orb.
Nassa Antillarum, d'Orb.
Oliva reticulata,
O. parvula, Mart.
Columbella nitida,
Marginella avena,
M. guttata, Dill.
M. apicina, Mart.
Cypræa, 5 sp.
Natica, 2 sp.
Pyramidella dolabrata, L.
Cerithium, sp.
C. septemstriatum,
Nerita, 4 sp.
Modulus perlatus, Dill.
Turbo castaneus, Chemn.
Trochus, sp.
Fissurella Barbadensis,
Emarginula octoradiata, Gml.
Patella pulcherrima?
Bulla maculosa, Mart.
Pecten, sp.
P. zic-zac, L.
Lima, sp.
Spondylus fimbriatus, Men.
Perna alata, Chemn.
Arca Listeri, Pp.
A. squamosa, Lam.
Pectunculus, sp.
Chama, sp.
Cardium medium,
Lucina pecten, Reeve.
L. Jamaicensis, L?
L. Pennsylvanica,
Venus, sp.
V. crenulata, Chemn.
Tellina radiata, L.
T. Cayennensis,
T. immaculata, Lam.
Amphidesma, sp.

Xagua Bay is a beautiful sheet of water, about fifteen miles long and from three to five broad. Several small streams discharge into it, of which the Damuji at the western end is the most considerable. Owing to the narrowness of the outlet, the bay is occasionally (though rarely) so filled with fresh water, poured out by these streams during the rainy season, that the fish and other marine animals living in it are destroyed in multitudes, and cast up on the beach. On its southern side the bay is in most places bordered by steep, rocky hills, among which are secluded coves, once the hiding places of buccaneers. It had formerly a shallow entrance at the eastern end, now nearly filled up, but which, a century or two ago, was open enough for small vessels. In addition to the other advantages they found here, this passage often enabled these marauders to escape punishment.

The town of Cienfuegos was founded by the Spaniards with the object of breaking up this nest of pirates, and has a mixed population of French and Spanish origin. On the north side of the bay the land is low, and the shore indented with numerous shallow coves. Between two of these the town is situated; it is closely built, and contains about six or eight thousand inhabitants. Along the waterside it is bordered with warehouses and wharves; the former are seldom more than one storey high, but are very spacious. Most vessels trading to this port load at the wharves, but such as are of large size move out from the shore to complete their cargoes, owing to the shallowness of the water on this side of the bay. The dwelling houses cover a slope extending from some low hills of marl and sandstone to the shore. The soft yellow rock in these hills lies in beds inclined to the southward at an angle of about thirty degrees; and water taken from the wells sunk in it is strongly brackish and bitter. The inhabitants of the town, therefore, depend chiefly upon supplies of rain-water, stored up in large tanks. Those who are not so fortunate as to possess cisterns are supplied by water carriers, who sell at a high price, *agua dulce* (sweet water) procured from springs in the valley of the Damuji, and brought thence in lighters. This precious liquid costs about as much as ice does with us in summer-time.

The geological formation, to which the yellow or buff-colored beds underlying Cienfuegos belongs, appears to be one of great thickness. I traced it in a northerly direction as far as Caunau, four miles from Cienfuegos, and did not then reach its limit. This was in a line nearly at right angles to the strike of the beds, and the intervening strata, where exposed, appear to have a very regular dip. The middle part of the series consists of beds, finer and more clayey—apparently also more calcareous—than those at the two places named. At Caunau the strata are quite compact and firm, becoming a coarse sandstone. For a mile or two back of Cienfuegos there are numerous fossiliferous layers in the more clayey part of the series, from which I obtained the following forms:—*Balanus*, sp., *Dentalium? Ostrea*, 7 sp., *Anomia*, sp., *Pecten*, 3 sp., Echinoids of two species (one a Scutelloid form,) also a large *Orbitoides*, a sharks tooth, and parts of the test of a crab, including the claws and carapace. Mr. J. Lechmere Guppy of Trinidad, W. I., who has kindly examined these fossils, says they are probably of Miocene age. The formation in which they occur is evidently one of great magnitude and importance, and I have no doubt occurs at many other points in this part of the Island. I should think it to be a mile in thickness where I crossed it. It is probably limited by the Trinidad mountains to the eastward, and does not appear on the lower part of the Damuji, where an older series comes to the surface.

The surface deposits both on this river and at Cienfuegos are of much interest, and especially the estuary-flats along the river itself. These flats exhibit the action of an agency which has played an important part in influencing the accumulation of estuary deposits in tropical regions. In approaching the outlet of the Damuji no break in the long green bank of foliage at the head of Xagua Bay enables one to divine where the river's mouth may be, but the entrance to the stream is betrayed by the flocks of pelicans and other natatory birds which seek their food on the long submerged bar extending out from the entrance. Even within the narrow opening, in what appears to be a broad tree-covered flat submerged by rising waters. there is not for several miles any visible bank to the river, but the waters spread out freely over the mud-flats upon which the mangroves grow. These trees by their great stools of roots and by numerous descending branches which root in the mud, interpose a strong check to the outward rush of the water when the stream is in flood, and cause it to deposit a great part of its sediment before reaching the seas. The mud-banks along that part of the Damuji upon which the mangroves grow are of a yellowish-brown or grey color, and contain shells of a small species of oyster, a mussel, a fresh-water cerite (*Cerithidium*), and a small conical univalve (*Melampus.*) These shells and the smaller organisms entombed in the silt, would add greatly to the fertility of soils derived from the mud-flats, if, through the action of disturbing forces in the earth's crust, they become elevated above the sea-level. Such alluvial tracts exist in the valley of the Damuji, and the indications elsewhere of recent changes in the level of the land render it probable that they exist in most of the river valleys of Cuba. A short distance above the Ferry, where the main-road from Cienfuegos crosses the Damuji, an extensive flat occurs, elevated about ten feet above the river; and at about the same level, near the town of Cienfuegos, there are surface deposits containing marine organisms. These bed rest upon clays, which conform to the inequalities of the upturned and eroded Miocene strata, and are found at different heights, from the present sea level to fifteen feet above it. They cover the bottom and sides of a shallow depression in the land through which a small brook runs and enters Xagua Bay just west of Cienfuegos. The fossiliferous layers rest upon certain buff-colored clays which form the subsoil at many points near the town, and which are covered here and there to a depth of from three to four feet by quartz gravel and sand. The coarser deposits have the aspect of ancient beaches or ridges, formed at the time when the depression in which they lie was a shallow cove extending behind the site of the town.

The shells in these sand and gravel beds are all of littoral species, and the water in which they lived appears to have been subjected to more or less agitation; for they are worn and the valves of the lamellibranchiates are generally severed from each other. The great majority of the species occurring here as fossils are still living on the neighboring coast; and from the relations of the deposit in which they are found, as well as the thinness of the beds. their want of coherence, and slight elevation above the Bay. I had supposed them to be Post-pliocene; but Mr. Guppy, to whom the shells collected here were referred, regards them as "probably Pliocene." The following are among the species occurring here.

Murex brevifrons,
Strombus gigas,
S. pugilis,
Pyrula melongena,
Nerita tessellata ?
Neritinia virginea,
Modulus lenticularis,
Cerithium versicolor,
C. vulgatum,
Bulla striata,
Ostræa, sp.
Perna obliqua,
Mytilus, sp.
Venus cancellata,
Lucina costata ?
L. tigrina (young),
L. Jamaicensis,
Asaphis rugosa.

At Santa Lucia Brook on the Damuji River there is a deposit of buff-colored, calcareous marl, which at some points nearly fills the little valley through which this stream runs. I had no means of measuring its height above the river, which at this point is a tidal estuary, but think that it may be roughly estimated at one hundred feet. This calcareous mass contains leaves of the jucaro, or olive-bark tree, *Bucida Buceras*, the two mangroves *Rhizophora mangle* and *Avicennia nitida*, a fern, a palm? and fragments of other plants. With these there were a few valves of a large species of oyster and some mussel shells, apparently the same species as that occurring in the surface beds at Cienfuegos.

Intermediate in height between the marl of Santa Lucia brook and the deposits already described near the sea-level, there is another surface layer of a dark color exposed along the slopes of the low hills on both sides of the Damuji. Beds of this nature fill the bottom and cover the sides of a small embayment of the land through which Labarinto Brook (the first one north of Santa Lucia) flows to the river. This deposit is not scarped into terraces like the alluvial flats at lower levels in the valley, but is spread with much regularity over the slopes descending to the river. The soils which it yields are called *tierra negra* (black earth), and are greatly relied upon for the production of heavy sugar crops; canes planted on them are less liable to suffer from drought than on other soils, and do not require renewal for a great number of years.

Higher up on the hill sides about the Damuji, a yellow clay may be seen emerging from beneath the *tierra negra*, and extending upwards—except where denudation has removed it—to the summit ridges on each side of the valley. These clays closely resemble those spoken of in connection with the Post-pliocene deposits about Cienfugos, and correspond to them also in their relation to the overlying beds. They come to the surface at many points in the country around Cienfugos, and are evidently the oldest of the surface deposits in that district. In many respects they are analagous to the yellow loam which, according to Prof. E. Hilgard,* "in most cases forms the subsoil of the Gulf States" being spread over a wide area in the basin of the Mississippi. This deposit was greatly eroded and in many places entirely removed when the submerged tract upon which it was thrown down rose again sufficiently high to bring it within the influence of the ocean surf. Large tracts on the ridge westward of the Damuji have in this way been entirely stripped of their surface covering, leaving the subjacent limestone beds exposed to view. These now present a very picturesque appearance, rising in pinnacles and sharp angular masses above the thin soil: worn as they are by the hot tropical rains which for centuries past have coursed down their sides, these marble pyramids have a striking resemblance to the white tents of a military encampment.

Elsewhere the sea has left upon this ridge and the shoulders of land projecting from it extensive gravel banks, giving further proof of the sweep of the sea over the low ridge separating the valley of the Damuji from the long dry gently sloping plain which descends westward to the great Zapato Swamp. Such gravelly soils are usually accompanied by loamy lands, which are often occupied as farms for the production of fruit and vegetables, and, when exhausted, as pasture grounds for the herds of cattle used in working the estates. Other tracts of this nature are reserved as wood-lands to supply fuel to the sugar-mills.

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* Am. Jour. Sci. Dec., 1871.

On all these higher swells and ridges, where gravel or sandy loam does not form the soil,—as well as on the slopes extending down toward the river, but above the land covered by *tierra negra*—another kind of soil denominated *tierra colorada* prevails. This deposit overlies the yellow clays, but I do not know whether it also passes beneath the *tierra negra*, or terminates at its borders. It is considered a valuable soil for the production of sugar: the canes grown upon it need to be renewed every three years, but the quality of cane-juice obtained from plants grown on this kind of land is regarded as much superior to that yielded by canes grown on the dark lands of the lower levels. *Tierra colorada* varies from cinnamon color to a chocolate-red, and its peculiar tint appears to be developed by the disintegration of older surface deposits and limestones. The red color is brightest in those thin coatings of soil which only half conceal the white limestone ledges on the ridge west of the Damuji, and results from an abundant admixture of red oxide of iron. In following these soils westerly beyond the ridge, and in the direction of the Zapato Swamp, the iron oxide predominates more and more, till at length the thin covering of earth is chiefly made up of little ferruginous nodules of the size of swan-shot. In this direction the soil looses its fertility, and the woods which cover the *tierra colorada* on the Damuji give way to wide wastes of dry land covered with thin grass, and dotted here and there by clumps of low thorny bushes. The barrenness here seems in part due to the want of a subsoil, and the ease with which the surface waters escape into crevices in the limestone rocks below, leaving the soil to be parched by a hot tropical sun.

The clay beds and gravel ridges, which are spread over the surface of the Miocene marls and sandstones between Cienfuegos and Caunau, yield pale buff colored soils, which are cultivated on the farms and small sugar plantations of that neighborhood; but the tillage lands here do not appear to be so productive as those of the Damuji. The clay beds of Cienfuegos are worked for making tiles and brick of which there is a large consumption in the town. In the waste heaps on the sides of the clay pits opened for this purpose, lie numbers of the shells of large snails which have buried themselves in the clay to remain during the dry season.

The land shells of Cuba and indeed of the West Indies generally, are of great interest to the naturalist; not only on account of the profusion in which they occur, but also from the great numbers of species and genera, and the very peculiar forms of some of them. Among the tropical snails, some like *Helix Imperator* and *H. Sagamore* rival in the solidity of their shells the stony gasteropods of the ocean: many shells of the genera *Pupa*, *Cylindrella*, *Cyclostoma*, *Chondropoma* and *Trochatella* are highly colored and strongly marked, like the ocean snails. One *Cylindrella* has straightened out its last coil in the manner of *Magilus*, a marine form of the Indian Ocean; while *Glandina* and *Oleacina* will pass for papery olive shells. The "agate shells" (*Achatina*) are the giant pulmonates of Cuba and carry on their backs shells which are elegantly formed, prettily marked and of large size. I give here a list of a few species met with when collecting Post-pliocene shells near Cienfuegos, for the names of which I am indebted to Mr. Thomas Bland of New York, to whose article on the land shells of the West Indies I shall have occasion to refer further on:—*Helix auricoma*, Fer.; this species is quite abundant and shews considerable variation; *H. Bonplandii*, Lam; *H. Poeyi*, (young); *H. Cubensis*, Pfr.; *Achatina fasciata*, Muhl, in several varieties, nearly as common as *H. auricoma; Cisula inculta*, d'Orb; *Helicina adspersa*, Pfr.; *H. submarginata*, Gray; *Oleacina solidula*, Pfr.; *Glandina*, sp.

The Damuji has a number of estuary shells, including a small species of oyster, multitudes of which cling to the roots and trunks of the mangroves; also *Cerithidium*, sp.; *Melampus coniformis? Balanus*, sp., and *Mytilus*, sp. The shells of *Cerithidium* and *Mytilus* were found in small numbers in a fresh pond at the mouth of Labarinto brook in company with *Planorbis*, 4 sp.; *Physa*, sp.; *Valvata*, sp.; the fresh-water cerite (*Cerithidium*) is an amphibious animal, climbing on trees, and may have crawled over the low bank which divides this pond from the river.

On both sides of the Damuji, a series of strata are exposed, consisting chiefly of limestones, but apparently separated into two bands by an intermediate body of sandstones. The series as a whole was not well exposed at any of the points I visited; but the limestones, which appear at the river side on the Constancia Estate, and are also exposed in the vicinity of the buildings on Concepcion Estate opposite to it, cannot be regarded as the same with those alluded to in the preceeding remarks on the surface geology of this region. The limestones there spoken of as cropping out on the ridge west of the Damuji are clearly underlaid by sandstones holding Cretaceous fossils; and although sub-crystalline, fine-grained and homogeneous, cannot be regarded as primary. Their lower beds are grey and impure, but did not yield any recognizable fossils: the grey grit and sandstone, however, upon which they rest, contains shells of the genera *Conus* and *Oliva*, several small undetermined bivalves, and numbers of a small echinoid form resembling *Ciderites*. These organisms were observed in the sandstones, on the hill-side just above the buildings of the Constancia Estate, where both the limestones and sandstones dip westward at a very low angle. I was informed that the sub-crystalline limestones of this group rise to the surface in the Zapato Swamp, where there are sharp pinnacles of rock similar to those already described on the ridge west of the Damuji. Crystalline limestones compose a large part of the strata which rise to the surface again still further westward in the Isle of Pines.

I observed the arenaceous strata of this series at two other points in the river valley, which would if connected carry them diagonally across the stream. The first of these places met with in ascending the river is the *Passa*, or Ferry, on the Cienfuegos road. There are here grey and buff sandstones, containing shells of the genera *Exogyra*, *Ostræa*, and *Inoceramus*. Also at Limones, a farm in a little valley further up, there are beds of dark red and grey sandstone holding shells of the genera *Ostræa* and *Inoceramus*. The sandstones are accompanied by a brown conglomerate holding pebbles of felspar-porphyry and diorite.

The limestones of Constancia Landing and Concepcion Estate, already mentioned, lie along the eastern side of the arenaceous band seen at Constancia buildings and the "Ferry." They are mostly of a pale buff tint, and are replete with organic remains—being in fact Hippurite-limestones. This type of shells (*Hippurites*) of several species, with *Caprinella* and *Caprotina?* abounds in them; and they also contain corals and several kinds of univalve and bivalve shells among which are a large *Oliva*, a

Conus, an oyster of the type of *Ostrœa cristata*, *Echini* and sponges. These fossils were seen in a ravine near the buildings of the Concepcion Estate on the eastern side, and at the Landing of the Constancia Estate on the western side of the Damuji.

One feature worthy of remark in the Cretaceous rocks of the district of Cienfuegos is the evidence they give of the extent to which the hardening process has gone in them; this condition of the beds is not limited to the district on the Damuji which I have spoken of, but characterizes them over a large area. In this respect they differ greatly from the strata of cotemporaneous age in the Southern States of the Union; for in hardness and coherence they resemble the carboniferous series of the Maritime Provinces of Canada; but they are not so hard as the Silurian and Lower and Middle Devonian of this region, from which the bituminous matter has been expelled.

The evidence afforded by the Cretaceous and Tertiary rocks of the momentous changes which have occurred in the later geological periods over the whole of the West Indian area, are particularly striking to those who witness in Canada and the Eastern United States indications of violent disturbances in the earth's crust only in periods much more remote. Such movements had ceased here in times long anterior to those in which the *Gryphœæ* and *Inocerami* of the Damuji valley lived. While the Caribbean region evinces the action of intense forces in the upheaval of mountain chains during the later Secondary and Tertiary ages, it also gives indications of those gentler oscillations of the earths surface which marks those epochs, as well as the Post Tertiary, throughout the Appalachian and Laurentian regions of the neighboring continent.

Any one who will take the trouble to examine a good map of the West Indies, will observe two strongly marked lines of elevation parallel to each other, namely, the line running through Jamaica, the south side of Hayti, Porto Rico and the Virgin Islands; and that running from the Grand Cayman to Point Maysi at the eastern end of Cuba. These are supplemented on the north by the line of elevations in the Isle of Pines, the Jardin Cays, &c.; and on the south by the range indicated in the Seranella, the New Shoal east of it, and the islets off the Carabasca Lagoon. These E. to W. ranges with the N.W. to S.E. courses of some important mountain systems in the large islands, Cuba and San Domingo, combine to give their present outline to the greater Antilles. Another system of submarine elevations evidently governs the arrangement of the Windward Islands; for if the position of the shoals and banks connected with them be traced, it will be observed that they also are arranged in parallel and overlapping groups. In this case, however, it will be found that the ridges have a S. to N. course, not an E. to W. one, as in the Greater Antilles. The point where these two mountain systems meet (St. Thomas, &c.) is even yet the scene of devastating earthquakes.

The mountain chains which I have attempted to describe are the frame-work or skeleton of a large continental area now submerged, and of late years have yielded some curious and interesting proofs of the changes which this whole region has undergone. Mr. Thomas Bland, well known for his study of the land shells of the West Indies, in an article lately published by him,* presents some valuable information bearing upon the past physical history of the Windward Isles. From the observations of the British Admiralty Surveyors, he shews that the elevation of these islands and the adjacent sea-bottom to the height of forty fathoms above the present level, would unite the whole group of the Virgin Islands with Porto Rico, and would make six large islands of several groups of islands extending southward to the coast of South America. And it would appear that a connection even more complete than is thus foreshadowed, existed in comparatively late geological times; for he tells us that "taking a wide view of the land-shell distribution in the West Indies, it may be said that the fauna of the islands on the northern side of the Caribbean Sea, from Cuba to the Virgin and Anguilla banks, was derived from Mexico and Central America; and that from the islands of the eastern side, from the Antigua and St. Christopher banks to Trinidad, from tropical South America. It is noticeable that the mountains in the former islands, range generally from west to east, but in the latter from south to north, except in Tobago and Trinidad, where they are parallel with, or in the same direction as the coast mountains of the adjacent continent. The present geological condition of the islands affords ample evidence of the lapse of vast periods of time in the earlier Tertiary epochs, during which the limestone formations, extensively developed in most of the islands, were deposited.

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* Am. Philosop. Soc. N. York, Mar. 3, 1871.

The white limestone of Jamaica, referred to by Sawkins (*Geology of Jamaica*, London, 1869) to the Post-pliocene, covers more than three-fourths of the Island, and is computed at 2,000 feet in thickness. It rests on the yellow limestone (Miocene) which, he remarks, during the deposition of the former, "sank to great depths, in some places apparently 3,000 feet, so as to permit the growth of those great coral structures, from the debris of which the enormous development of the white limestones has been derived. The lapse of time required for these important phenomena cannot be easily realized by the imagination." Mr. Bland proceeds to say "that the islands, or some of them, were formerly united and formed part of an ancient continent, may, it would seem for various reasons, be inferred." Referring to the Anguilla cave remains, Prof. Cope remarks (*Proceed. Acad. Nat. Sci.* Phila. 1868) "that the Caribbean Continent had not been submerged prior to the close of the Post-pliocene, and that its connection was with the other Antilles, while a wide strait separated it from the then comparatively remote shores of North America." Mr. Bland adds "that the occurrence with the Anguilla fossils of a land shell of a species now living, points to the age of the existing fauna, but the marked difference, both generic and specific, between the present land-shell fauna of the islands upon and to the north and west of Anguilla bank, and those to the south of it, may be taken as evidence of their early and continued separation."

It is not a little remarkable that the Caribbean Continent, whose former existence is thus revealed to us, should have so nearly coincided in time with the Glacial Period in North America. Could this mass of land, the greater part of which received its inhabitants from Mexico and Central America, have closed the outlet of the Caribbean Sea? The existence of such a barrier would go far to explain the extreme cold of this period in North America; for had there been at this time no outlet from the Caribbean Sea to the Gulf of Mexico, the tepid waters which enter that sea on the east and pass out again by the Florida passage and Gulf Stream, would have been compelled to commence their journey northward at a point much further east than they now do, and so would not have flowed along the North American coast, nor carried to Northern Europe the temperature of low latitudes. It is possible that the Antilles may have been populated in successive stages from Central America and Yucatan, without actually closing the strait which unites the Caribbean Sea with the Gulf of Mexico; but the near coincidence of land expansion here with the Glacial period at the north, is suggestive of a more complete separation. Such a parting of these two seas and the elevation of the mountain chain of which the Windward Isles are the emerged crests, would also account for the meeting of the two land-shell faunas of the West Indies in the islands furthest to windward, a circumstance difficult of explanation except upon the hypothesis of a continuous terrestrial road from the South American Continent as well as from Mexico. Mr. Bland shews that while the Cuban genera diminish in the number of species as we proceed eastward through the chain of the Greater Antilles, the South American genera are reduced in number as we go northward along the chain of the Windward Isles. Both lines of migration meet in the Anguilla group, the most north-easterly part of the old Caribbean Continent now remaining above the waves.

But while it would thus appear that the West Indian land area was formerly of much greater extent than now, there are, on the other hand, indications which point to a subsequent reduction in size of some of the Islands, much below their present extent. Of the larger animals which lived on the Anguilla group at a period comparatively recent, none are now to be found; nor were any existing, either here or on the larger islands, when Columbus discovered the Indies. There are no indigenous animals of large size in Hayti; and the largest in Cuba is a small rat-like creature, dwelling in trees, called *jutia*. From this it may be inferred that at some late period the Antillean region had been rendered untenable for large animals. Perhaps nothing would conduce more to this result than the engulfment of the Caribbean Continent, leaving only small isolated patches of land above the ocean. In most cases such islets would be sharp mountain peaks, places where the larger mammals could with difficulty maintain their existence and propagate their kind. From what has been previously said it will be seen that a submergence of this nature has occurred in Cuba, the largest of these islands, in times which, geologically, are quite recent; and it is probable that most of the other islands shared in the submersion which took place in the Greater Antilles. In time other movements in the earth's crust led to a re-elevation of this region; the plants and animals inhabiting it—for a time confined to small areas—again spread abroad over the emerging land, and the West Indies assumed the appearance which they now present to us, having, as regards their fauna, two groups, one with South American, the other with Mexican affinities.

It is not a little curious that when Columbus discovered these islands, he found them occupied by two races of men—the warlike and aggressive Caribs inhabiting the Windward Islands, and the mild and docile Indios dwelling in the Greater Antilles.

(*To be continued.*)

GEOLOGICAL FEATURES OF HURON COUNTY, ONTARIO.

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Before commencing a description of the geological structure of this County, a few words on the physical outlines of the district are necessary. Situated on the eastern shore of Lake Huron, and bounded on the north by the County of Bruce; on the east by the Counties of Wellington and Perth; and on the south by the Counties of Middlesex and Lambton, this portion of Ontario is not only remarkable for its natural scenery and fertility, but has of late years, through its boundless resources of rock salt, attained a somewhat conspicuous position in the commercial world. Generally speaking the character of the region is gently undulating, with here and there a few limestone outcrops and escarpments on the north-eastern limits, which, by their disintegration, have to no small extent enhanced the quality of the surrounding land. The average altitude above the sea-level is about 950 feet, although between the Townships of Tuckersmith and Hibbert there is a ridge which rises to a summit-level of 1,050 feet. The streams as a rule are small, and undergo rapid oscillations of level, increasing in the spring to torrents of considerable volume, and conspicuously diminishing towards the fall, when numerous small deltas are formed in the low lands, composed for the most part of thin alluvial accumulations. The Maitland River which forms the dividing line between the Townships of Goderich and Colborne is exceedingly tortuous in its course. It was formerly denominated the *Red River* by the

Indian traders—a name which was probably given it from the color of its waters, which, although perfectly transparent, are generally of a reddish-brown tint. The Indian name for the river is *Menesétung.* Near its mouth the stream is broad, and its bed is composed of course gravel and sand, underneath which a moderately thick stratum of peat has recently been discovered; but, after ascending it for a few miles, the channel becomes contracted, forming as it were a ravine-like basin, denuded by the action of its waters in the limestone fundamental rocks of the locality. The Bayfield River, on the other hand, drains the central, or rather the more southern portion of the County, and flows into the same waters some twelve or thirteen miles south of the *embouchure* of the Maitland. The only other river of importance is the Rivière aux Sables (South) which forms the southern limit of the County. Flowing at first in a north-eastern direction, and bounding the Township of Bosanquet on the east, it makes a bend at its northern extremity, then running nearly parallel with the coast for about ten miles, it enters the Lake. Extending along the western limit of the County, in a north and south direction, lies a remarkable ridge composed of water-worn gravel and fine sand, whose general contour is parallel to the present margin of the Lake. Conforming to the irregularities of the coast for about sixty miles, and at an average distance from it of a mile and a half, it reaches the sandy flats of the Rivière aux Sables, and is finally lost. The western slope of this lacustrine terrace inclines gradually towards the present lake beach, and within this limited area, deposits of shell-marl are frequently found. Future researches will no doubt prove the existence of other terraces lying more to the eastward, which will doubtless throw much light on the former physical features of this lake-area. Our terraces are monuments of great geological value, indicating to a certainty the former submergence of our land under the waters of a vast fresh-water inland sea.

Throughout this tract of country there is ample evidence of denuding forces at work, both prior and subsequent to the Glacial Period. The high clay cliffs along the margin of the lake, and the numerous ravines and valleys, which are so conspicuous along the courses of the above-named rivers, afford unmistakable proofs of the former physical conditions of this region.

The palæozoic strata of this western portion of Ontario are everywhere covered by the vast accumulations of the Drift Period, which have to such an extent obliterated all access of approach that their study can only be of the most partial nature. It is only along some of our river channels, and at intervals on the margin of the lake, that there is sufficient room for either stratigraphic or palæontological investigations. The fundamental rocks of this district belong, with but one or two exceptions, to the Corniferous limestone formation of the Middle Devonian system. These Devonian rocks of America, as laid down by the New York geologists, consist of the following grand sub-divisions or Periods, viz.: 1. The Oriskany sandstones, 2. Corniferous limestones, 3. Hamilton shales and sandstones, 4. Portage and Chemung groups, and 5. The Catskill red sandstones. The following may be given as a table shewing approximately the geological position of the different formations observed either as outcrops or by borings in the area in question:—

Middle Devonian.	Corniferous limestone formation.	
	Onondaga limestone.	
	Schoharie grit.	
Lower Devonian.	Cauda-galli grit.	
	Oriskany sandstone.	
Upper Silurian.	Lower Helderberg group of Vanuxem, including the Tentaculite limestone, or so-called Water-lime sub-division.	
	Onondaga formation, or Salina group of Dana.	
Middle Silurian.	Guelph and Galt limestones.	
	Niagara formation.	Anticosti group.
	Clinton "	
	Medina "	

Of the subdivisions of the Middle Devonian System only one is found in the locality under consideration. This is the Corniferous limestone formation, which forms by far the greater portion of the underlying surface rock. The Lower Devonian is not apparently represented in this County, although numerous fragments of the Oriskany sandstone are scattered here and there on the surface of the ground as angular and evidently lately detached erratics. The rocks of the Lower Helderberg group of the Upper Silurian series are, with the exception of the Tentaculite limestone or Water-lime beds, entirely wanting in Ontario. This division is described by Vanuxum as being essentially a dark blue magnesian limestone, with interstratified drab-colored beds which yield by calcination a very valuable hydraulic cement. It is met with in two localities in the County, and in each presents similar lithological characters. The Onondaga Salt group, or Salina formation of Dana, is found to extend under the whole

County, as far as can be ascertained by borings, forming the foundation rock, so to speak, of the Corniferous limestone, and where this is absent, immediately underlying the so-called Waterlime beds.

The Guelph formation—the uppermost layer of the Middle Silurian series—is only observed by means of borings at a depth of about 1,000 feet from the surface of the ground, and underlying the most recent deposit of rock salt. Of the presence of the Clinton and Medina formations underlying the rock-salt and gypsiferous shales of the Salina group, we have but doubtful evidence; and it is only by means of specimens of rock brought up by the sand-pump, during the operation of boring, that we arrive at the probability of their existence within the average depth of 1,150 feet from the surface. The more important exposures of rock observed within the limits of this district are given in the following list proceeding from north to south:—

1. The escarpments in Howick.
2. The outcrop on the falls of the Ashfield River.
3. The outcrop between the Townships of Ashfield and Colborne.
4. The outcrop on the Maitland, one-half mile from Goderich.
5. The outcrop on the 1st lot of the 1st range of Colborne.
6. The outcrop on the Maitland, 1½ miles from Goderich.

The Corniferous limestone which is the essential rock-component of the above exposures, occupies in Ontario a superficial area of about 6,500 square miles. It is, comparatively, a pure limestone, containing no traces of magnesia which to a great extent enters into the composition of many of our calcareous formations. Its beds are abundantly charged with organic remains, some of which are little more than aggregates of chalcedonic quartz with intermingled calcium carbonate. Numerous beds of chert or hornstone are also especially characteristic of these limestones, giving the name Corniferous to the formation.

1. Throughout the Township of Carrick, and extending south into Howick, occur numerous outcrops of limestone, forming escarpments from twenty to thirty feet in height. These consist for the most part of blue and grey limestones of the Corniferous formation. Their sharp outlines and acute indentations seem to point to the existence of violent denuding agencies, probably contemporaneous with the re-elevation of Western Ontario towards the end of the Glacial Drift.

2. At the falls of the Ashfield River, about a quarter of a mile from its mouth, occur thin beds of calcareous sandstones, interlaminated with silicious limestones, containing but scanty traces of animal life; the only species identified being *Spirifera bimesialis* (Billings). These fossiliferous beds immediately overlie the apparently unfossiliferous Tentaculite limestone, which, about two miles to the south-east, crops out only a few inches above the waters of the Lake.

3. Where the boundary line between Ashfield and Colborne strikes the Lake. near Port Albert, there is a cliffy outcrop facing the water, of a few feet in thickness, which is observed at intervals along the shore for about a mile. The rocks here exposed are entirely destitute of fossils, and consist of the following succession of beds :—

1. Yellow dolomitic limestone. 2. Thin beds of limestone filled with chert. 3. Dark grey sandstones more or less bituminous. 4. Thin limestones, with numerous crystals of calcite.

The lithological character of this outcrop at once indicates the existence of the Tentaculite limestone or Water-lime group. This formation is here found to rest directly upon the Salina shales and limestones, and to immediately underlie the Corniferous formation, the intermediate portions of the Lower Helderberg group being apparently unrepresented. In Western New York, and in some other localities in Ontario, where strata of this division are observed, a few fossils occur. The more characteristic forms met with are *Leperditia alta*, *Tentaculites ornatus*, and *Eurypterus remipes* (DeKay)—the latter crustacean form having been also discovered, according to Keyserling, in the Upper Silurian limestones of the island of Oesel in Russia.

4. About half a mile from the town of Goderich, on the banks of the Maitland, beds of yellowish calcareous sandstone, and dark grey dolomitic limestones, holding lenticular crystals of calc-spar, are exposed for a considerable distance along the river margin. They belong to the Water-lime group, and are entirely destitute of fossils.

5. Ascending the river for nearly five miles, strata of yellowish limestone interlaminated with grey slaty limestone in thin layers are observed. They belong to the Corniferous formation, which, a few miles to the S. E., attains a total thickness of 200 feet, as shewn by the recent borings for salt. The absence of this formation a few miles to the westward where the Tentaculite

limestone forms the fundamental rock of the district, may be accounted for, partly by powerful denudation during the upheaval of this area from the sea-bottom, and partly by the south-eastern dip of the strata. Here the beds are replete with fossils in a more or less silicified condition, the more important species being as follow:—

Zoophyta.

Fistulipora Canadensis, Billings.
Favosites Gothlandica, Goldfuss.
——— *hemispherica*, Shumard.
Syringopora Maclurea, Billings.
———— *Hisingeri*, Billings.
Zaphrentis prolifica, Billings.
———— *gigantea*.
Heliophyllum Eriense.
————— *Canadense*, Billings.
Favosites Basaltica, Goldfuss.
Michelinia convexa, D'Orbigny—the large cell openings being entirely silicified in most instances.
Eridophyllum Simcoense, Billings, and species of the following genera: *Phillipsastrea*, *Clisiophyllum*, *Diphyphyllum* and *Cystiphyllum*.

Brachiopoda.

Orthis Livia, Billings.
Strophomena rhomboidalis, Wahlenberg.
———— *ampla*, Hall.
Streptorhynchus Pandora, Billings.
Rhynchonella Thalia, Billings.
Pentamerus aratus, Conrad.
Spirifera duodenaria, Hall.
Stricklandia elongata, Billings, formerly *Pentamerus elongatus* of Vanuxem.
Atrypa reticularis, Linnæus, also occurring in the Wenlock limestones of Great Britain, in Sweden, Bohemia and in the Ural Mountains of Russia.

Lamellibranchiata.

Conocardium trigonale, Conrad.
Vanuxemia Tomkinsi, Billings.

Gasteropoda.

Loxonema Cotterana, Billings.
Euomphalus de Cewi, Billings.

Of the Cephalopoda only one or two undetermined species occur; whilst the Crustacean representatives are included in the genera *Phacops* and *Dalmannites*.

These fossil species are more or less common to the whole range of Corniferous limestone in the district to which the present observations are confined. Their specific characters have been minutely examined and described by E. Billings, F.G.S., of the Geological Survey of Canada, to whose very elaborate contributions to palæontology the writer is chiefly indebted for descriptions of such fossil types as come under review in this paper.

6. Descending the Maitland for three or four miles from the

last-mentioned outcrop, limestone beds occur in cliffs skirting the river margin. The uppermost beds of grey limestone, holding intercalated crystals and silicified organic remains, belong to the Corniferous formation; whilst the underlying strata of bluish limestone and fine-grained sandstone with irregular crystals of calc-spar, denote the presence of the Water-lime group. We have here exposed in one cliff two different formations belonging to two totally different geological periods; the uppermost or Corniferous belonging to the Middle Devonian System, and the underlying one or Tentaculite limestone being of Silurian age. The numerous intermediate formations, or those which in the geological scale intervene between the formations in question, were being slowly deposited in other localities while the Tentaculite limestone was for ages above the level of the ocean, or at least formed the basin of a very shallow expanse of water, uninfluenced by any currents whatever. Then immediately subsequent to the deposition of all these formations preceding the Corniferous, the long stationary Tentaculite limestone was gradually submerged to a depth of several hundred feet, and on its unruffled surface was deposited the Corniferous sediment, which subsequently was upheaved above the ocean, remaining comparatively motionless until about to be covered by the waters of the Glacial sea.

South of the Maitland river, no exposures of rock have been met with in Huron. Along the valley of the Bayfield we look in vain for the appearance of the underlying rock, the river through its whole course flowing over grey and blue clays of the Quaternary age. But even here something of geological interest awaits us. About three miles in a direct line from Lake Huron and lying partially buried amid the clays along the river margin, there is exposed what seems to be an outlier of a formation apparently higher in the scale than the Corniferous. Its beds are characterized by an extraordinary profusion of organic remains; the uppermost ones containing vast quantities of fragmentary Crinoidal stems which mark in a special manner the presence of certain strata of the Hamilton formation. Viewing it alike from a lithological and a palæontological point of view, the inference would naturally be that we have here an outlier of the Hamilton formation divided from the main area by denudation, and manifestly proving the former extension of these higher deposits along the slopes of that synclinal, whose course from Lake Huron to Erie is a somewhat unique feature in the physical geology of Western Ontario.

NOTES ON THE MARINE CLAYS OCCURRING AT THE RAILWAY CUTTING ON THE LEFT BANK OF THE TATTAGOUCHE RIVER.

By Rev. C. H. Paisley.

The deposit to which these notes refer is situated in Gloucester Co., N.B., about 2½ miles from Bathurst, on the left bank of the Tattagouche River, where it is crossed by the Intercolonial Railroad. It is 60 feet* above the river at low water, and 162 feet above the sea. The cutting that exposes the deposit is not entirely through, so that our information cannot be said to be complete. Near the highest part of the cut yet exposed, the bank presents a surface of about 40 feet, and gives the following section:

	Ft.	*Ins.*
1. Soil bearing spruce and fir trees	1—2	0
2. Coarse gravel	6—8	0
3. Sand, which, with an occasional thin layer of reddish clay, reaches a thickness of	10–12	0
4. Yellowish clay		9
5. Reddish sand	1	3
6. Reddish-yellow clay with threads of sand	1	8
To this depth the deposit seems to be non-fossiliferous.		
7. Greenish sand with an occasional valve of *Mya*, and innumerable minute fragments of shells, giving the bed such an appearance as is presented by the sand on the sea shore to-day	1	8
8. Coarse sand and reddish clay, so intermingled that, in some places, it is impossible to detect any stratification. In the sand which, on penetration for 1 foot, is found to be stained with iron rust, and which on exposure for a few hours becomes hard as a soft sandstone, occur occasional small angular fragments of quartz, slate, serpentine, &c., varying from 1 oz. to say 5 lbs. in weight. In many parts the clay assumes the form of nodular concretions, interstratified with		

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* These measurements give the heights to the level of the Railway, so that to get the height of the top of the deposit it will be necessary to add about 40 ft. They are both taken from high water mark at Campbelton, Restigouche; but the difference between that and the Bay Chaleurs is very trifling.

	the sand, and varying from the size of a pea to that of a hen's egg. In other parts the stratum of clay can be detected only by its presence in certain shells when taken from the bank. Very fossiliferous. (See list of fossils below.) Varying from almost a thread to	2	0
9.	Reddish sandy clay. For fossils *vide infra*. Average thickness about	2	6
10.	Red and blue clays. Tough. So interstratified as to present a beautiful banded appearance. An occasional *Mya* or *Natica* occurs, but so much decomposed as not to stand removal. This bed extends downward to the level of the road, say 5 or 6 feet, but how far below there is no means of determining.........	6	0

Although fossils are found sparsely in the lower part of No. 7 and in the upper part of No. 10, the fossiliferous layer may be said to consist of Nos. 8 and 9.

In No. 8 I have found the following as determined by Dr. Dawson, viz.:

Saxicava rugosa.
Mya arenaria.
Also young shells of the same (not very numerous).
M. truncata.
Leda pernula.
—— *glacialis.*
Nucula tenuis (*expansa*) (scarce).
Aphrodite Grœnlandica.
Macoma calcarea.
——— *Grœnlandica.*
Cryptodon Gouldii (?).
Natica clausa (*affinis*).
Buccinum undatum.
Balanus crenatus.
——— *Hameri.*
Mytilus edulis.

In No. 9 I have found :

Mya arenaria. Very abundant.
—— *truncata.* Rare.
Nucula tenuis. Abundant.
Balanus crenatus.
——— *Hameri.*
Young *Mya* in great abundance.

As it is almost impossible to tell in which stratum of the fossiliferous bed (i. e. whether in the sand or clay) the fossils occur), I will give the material with which they were filled when removed from position :

Saxicava, *Leda glacialis*, *L. pernula*, *Buccinum*, *Natica*, *Aphrodite Grœnlandica*, *Balanus* almost invariably with sand, *Macoma calcarea* and *M. Grœnlandica* sometimes with sand and sometimes in clay, but more frequently with the former, *Mya arenaria*, *M. truncata*, young *Mya*, *Nucula tenuis*, *Mytilus edulis* almost invariably with clay.

I have examined a number of the clay concretions mentioned above, but have not been able to find in them any fossil remains.

The right-hand bank of the river I examined in a cutting made to the same level as that on the left, but found no fossils. The only exposure was a bed of coarse reddish gravel.

The overseer of the railroad bridge now being built in the locality informed me that in digging 8 feet below the level of the river, he found that the rock to which he came inclined in opposite directions on opposite sides of the stream. If this be so the Tattagouche River will occupy the crack in an anticlinal axis, and the deposit examined in these notes will occupy the side dipping towards the sea.

BATHURST, Nov. 19, 1872.

EPIZOOTIC INFLUENZA IN HORSES.

A paper on this subject was read by Mr. D. McEachran, V.S., before the Natural History Society in December last, and as the subject is one of much interest, we publish a somewhat lengthy abstract, being unable, from want of space, to give the paper in full.

Mr. McEachran begins by stating that diseases which attack a number of persons at the same time, and which are supposed to depend upon some atmospheric influence, are denominated *epidemic;* while those of a similar nature, but occurring among the lower animals, are termed *epizootic*. The term *zymotic*, suggested by Dr. William Farr, is, however, more frequently employed in medical nosology than either of the above.

In the greater number of these zymotic diseases the blood seems to be especially acted upon by poisons, and is found to undergo important changes, both chemical and histological. The poisons which are supposed to produce these changes are said to be of organic origin, either derived from without or generated within the body. In the living animal a double process is continually going on, a building up, and a removal of waste material; and while it is essential to have a regular supply of nourishment to maintain the body, it is equally requisite that the effete or waste products be regularly and thoroughly removed. Otherwise the blood will be rendered unfit for performing its functions.

It must appear evident that the atmosphere is liable to contain many impurities, derived from the decomposition of animal and vegetable matters. These entering the blood in the process of respiration, poison it, and produce such diseases as the one under consideration. The most careful chemical analyses fail to detect them, and we recognize them only in their effects upon the blood and system in general.

Like all poisons, those producing zymotic diseases appear to be subject to certain general laws, the most important of which are, according to Dr. Aitken, (1) That they have all certain definite and specific actions; (2) That they all lie latent in the system, a certain but varying period of time before their actions are set up; and (3) That the phenomena resulting from their action vary in some degree according to the dose and the receptivity of the patient.

Zymotic poisons have been divided into three classes, viz., 1. Paludal malarious poisons; 2. Animal malarious poisons; 3. Specifie disease poisons. The first do not exert their influence upon domestic animals to the same extent as upon man. They result from the decomposition of vegetable substances, and may be carried by the wind to considerable distances, giving rise to agues, rheumatic fevers, and other diseases. The second arise from the decomposition of various animal substances. The winter season, when the dwellings of man and beast are too often overcrowded and ill ventilated, is favourable to their development. The blood becomes charged with them, and they exert a depressing influence upon the system. The third or "specific disease poisons," are derived from the bodies of animals suffering from the disease; for the body once contaminated by the poison, is capable of generating it and spreading the disease to others.

Mr. McEachran here gives several extracts from Dr. Beale's book on "Disease Germs," relating more especially to the spread of infectious diseases; but we must omit them and pass on to such points as the symptoms and treatment of Epizootic Influenza, using Mr. McEachran's own words as far as possible.

As is generally known the present *epizootic* made its appearance in Toronto in the beginning of October, and there soon spread to such an extent as to completely arrest all business depending upon horses—scarcely a horse escaping. From Toronto it gradually extended in an easterly direction, until, on the 8th of October, one case was detected in this city. On the morning of that day my attention was directed to a peculiar deep cough affecting a mare belonging to a gentleman in this city. On examining her closely, I found that she presented symptoms indicative of influenza in which bronchitis was prominent. The gentleman had bought a pair of carriage horses in Ontario which were both coughing; but as they did not appear to suffer much, it was supposed to be the result of a slight cold contracted in coming from Toronto here. However, on examination, I found the same indications of influenza as in the mare.

On the following day four cases occurred in a stable in the same street; on the 10th, six more in different parts of the city; and on the 11th as many more. By the 17th scarcely a horse in the city could be said to be free from it. To give an idea of the suddenness of its spread, I may mention that in one stable which I visited on Saturday evening, there was not a single case, but when I was sent for next morning, half the horses were affected, and before night the entire stock of about fifty had the disease.

Symptoms.—The period of incubation would seem to be very short; but I think that I am right in saying that the time which the poison takes to become developed after its introduction into the system is short, say from one to three days. A peculiar deep cough early sets in, and in most cases there was a copious discharge from the nostrils. The discharge was generally thick and purulent; in a few cases it had the peculiar orange colour which we find in typhoid fever, but often it was white and curdy. As a rule, however, it was the ordinary muco-purulent discharge seen in catarrhal affections. In old horses, especially in protracted cases, blood was often mixed with it. There was occasionally also a purulent discharge from the eyes. The mucous membranes were swollen, soft, and generally of a pale buff colour, though in some old animals they had a distinctly yellow tinge, especially observable in the sclerotic coat and the lining of the eyelids—an indication of hepatic derangement. The throat in all cases was swollen, the thyroid and submaxillary glands slightly, but the mucous membrane of the fauces, posterior nares and epiglottis considerably. This occasioned difficulty in swallowing, and brought on severe fits of coughing. Quantities of thick gummy sputa were frequently coughed up from the throat, but in several cases became so adhesive that death was occasioned by its obstructing the air passages.

The typhoid form of fever was a prominent symptom. The mouth was hot, but not dry, being kept moist by the constant secretion from the throat, the pulse seldom over fifty-five to sixty, the respiration rapid and abdominal, the flanks contracted and the extremities usually cold. In mild cases the appetite continued fair, but the soreness of the throat often occasioned difficulty in swallowing. Debility was noticeable in a marked degree. The bowels were usually costive, but in some cases unduly relaxed.

As the disease progressed, debility increased, the appetite failed, fits of shivering came on, and a depressed line could be seen along the cartilages of the ribs; the head protruded, the nostrils were distended and the pulse quick and irregular; in fact, the symptoms of acute congestion of the lungs were presented in a marked manner. In these cases it was found best to induce superficial circulation by increasing the clothing and rubbing and bandaging the legs. A diffusible stimulant was also given by way of equalizing the circulation, and marked relief was afforded by stimulating the sides of the chest with an embrocation. If, however, the case were neglected, or improperly treated, *pleuro-pneumonia* of a typhoid type resulted. The animal then stood with the head protruded, the ears drooping and cold, the fore-legs used as props, the breathing quick and short, a depressed line from the flank to the sternum, the cough muffled, and the act of coughing painful. In many cases thoracic effusion and œdema of the legs occurred to a considerable extent. This was seen more particularly in old animals, especially in secondary attacks. In some horses there were painful nodulous swellings along the sides of the chest and belly, and often in the groin and thigh; the breath, moreover, had occasionally an intolerable odour.

Post-mortem Examinations.—Several rather hurried *post-mortem* examinations were made, and showed that the respiratory organs were diseased in a marked degree. The mucous membrane from the nostrils to the air-cells was thickened and soft, and the sub-mucus tissue, particularly at the posterior nares, thickly infiltrated. The epiglottis and laryngeal membrane were also thick and soft; and in one case the entire fauces were black and gangrenous. The lungs were black and very much congested, the right lung in one animal being completely disorganized, and the chest about a quarter filled with discolored unhealthy serum. The pleura was thickened and covered by deposits of soft easily broken down lymph of a dirty whitish-yellow colour, with no adhesions.

The digestive organs did not show signs of any special disease, with the exception of the liver, which was much congested and easily broken up. The vessels of the brain and cord were slightly congested, and the heart invariably filled with large coagula of black grumous blood. The tissues generally were soft and flaccid, and decomposition set in very shortly after death.

The blood showed the most marked signs of disease. Its colour instead of being scarlet was almost black, and the separation of the serum from the clot was very incomplete. The white corpuscles were found to be much larger and much more numerous than in healthy blood; while the red were small, irregular in outline, and not collected in meshes of the plasma. The latter, moreover, were of a very light colour. We can at once see that blood in such a condition is incapable of nourishing and purifying the tissues.

When examined with a high magnifying power, forms could be detected, of which Mr. McEachran says: "Whether these are disease germs, or the products of the action of germs still more minute, on the vital fluid and the tissues through which it passes, I am not prepared to say."

Treatment.—In diseases of this class depletion ought not to be practised. The first point to be attended to is a supply of pure air; the stables should accordingly be thoroughly ventilated and drained, and carbolic disinfectants used. The efficient action of the several emunctories should be encouraged,—in the case of the skin by cleanliness and increased clothing, in that of the bowels by laxative food, and in that of the kidneys by saline diuretics. The stable should have a temperature of about 65° F., and hot mucilaginous drinks immediately provided.

Sulphite of soda has a beneficial action upon the blood. Some of the salts of potash, especially the nitrate, have also proved useful. Chlorate of potash makes a good wash for the throat, and bromide of potassium a still better one. The throat, and also the sides of the chest, when pleuritic symptoms are prominent, should be mildly blistered. Ordinary ammoniacal liniment may be used for this purpose. The nostrils should be frequently sponged with warm water containing carbolic acid; when the discharge was glutinous and obstructed the breathing, steaming the head proved beneficial.

After the third day tonics and stimulants were required.

When, in the secondary stages, chills set in, increased clothing, rubbing and bandaging the legs, and the use of a diffusible stimulant (sesquicarbonate of ammonia, acetate of ammonia, with spirits of nitrous ether, hot beer, gin or whiskey) soon restored the balance of circulation, and the congestion and shivering fits passed off. At this stage the amount of exercise depends upon the strength of the patient and the state of the weather. So long as the animal's head is up, his attention easily attracted, and he feeds tolerably well, he will be the better of exercise in the open air. The appetite, moreover, must sometimes be coaxed, for while some horses would eat hay, others would only take soft food. Apples, carrots, potatoes, bread, boiled oats and boiled barley are the best things to offer them.

In the third or dropsical stage, free scarification, or setons under the chest, should be resorted to. Exercise, hard rubbing of the legs, and tonics,—sulphate of iron, with ginger and gentian, given morning and evening, substituting a diuretic every second morning.

While the above remedies appear to have been useful, the treatment that proved most efficacious consisted in good nursing with generous diet in an easily digested form, an abundant supply of pure air, and exercise regulated according to the capability of the patient.

GEOLOGY AND MINERALOGY.

The Mineral Region of Lake Superior.—At the fifth monthly meeting of the Natural History Society, held on Monday evening last, Feb. 24th, Prof. R. Bell, of the Geological Survey of Canada, read a paper on the Huronian and mineral-bearing rocks of Lake Superior; an abstract of which will be found below.

In addition to the sandstones of the South shore of the Lake, which are unaltered sediments, in which traces of organic life have been detected, there are three well-marked groups of rocks on the Canadian side. These are the Laurentian, the Huronian, and the Upper Copper-bearing series of Lake Superior. Recent researches have shewn that Huronian rocks occur to a much larger extent than was formerly supposed, as bands alternating with Laurentian beds on both the North and South shores of the Lake.

To the northward of Lake Superior the Laurentian rocks for the most part consist of gray and reddish gneiss, with micaceous belts and mica schists. No minerals of any economic value have yet been found in these rocks, at this particular locality, nor do there seem to be any crystalline limestones.

In the same region the Huronian rocks are mostly of a schistose character, the most common of which are greenish schists and imperfect gneisses, the whole formation being rich in useful minerals.

A geological map, coloured in conformity with the latest discoveries, of the country lying to the north of the lake, and extending from its eastern point as far west as Lake Winnipeg, was then exhibited and explained somewhat in detail, the site of Lake Shebandowan being also pointed out. About two-thirds of this area consists of Laurentian beds, and the remainder of Huronian rocks.

In these latter deposits almost every conceivable variety of schist is to be met with. Among them are micaceous, hornblendic, dioritic, porphyritic, siliceous, cherty, chloritic, felsitic and argillaceous schists; more rarely dolomitic schists, and occasionally bands of magnetic iron ore and hæmatite. The lecturer stated that in this region gold and silver veins are always associated with dolomitic schists. The principal vein, to the south-west of Shebandowan Lake, and others, were referred to as bearing out this statement. In the Hastings series of rocks gold is also associated with dolomitic schists.

Various isolated patches of granite and syenite, some a few yards and others many miles in extent, but always connected with Huronian rocks, were pointed out on the map. In these masses there is no stratification.

In the Nipigon Basin, the Upper Copper-bearing rocks of Lake Superior attain their maximum development in Canadian territory. This area has the shape of an arrow head, with the apex pointed to the true North. The basin floor consists of marls, sandstones, &c., often covered with trappean outflows. The lecturer was disposed to think that this trappean outburst originated from some point in Lake Superior. The direction of the flow, as indicated by wrinkles on the surfaces of beds, is from the centre outwards. The occurrence of these traps on all sides of the lake, and their general arrangement, which presents an appearance as if the masses had been pressed against the rocky margin of the lake basin, are supposed to favour this view. The overflow in the Nipigon Basin, too, becomes exhausted in receding from Lake Superior.

Unlike the Laurentian rocks, in which, as before stated, no useful minerals have been found, the Huronian beds contain ores of iron, copper, lead, gold, silver and nickel. Copper is most frequent in quartz veins which intersect dioritic schists of Huronian age. The silver and gold veins near Shebandowan occur in similar schists, and were discovored by Mr. P. McKellar in the spring of 1871. A letter from Mr. McKellar to Prof. Bell was then read, which gave a description of the details. The principal vein Mr. McKellar writes, is of quartz, and is from two to six feet in thickness. In addition to gold and silver it contains ores of all the metals we have cited above as occurring in Huronian rocks. At this locality, in addition to the dolomitic band associated with intrusive granite, a great variety of Huronian schists occur. A vein of calc-spar and quartz cutting through Huronian schists on mining lot 3 A, on the North Shore of Thunder Bay, and containing native silver and nickel ore, was next described.

The main silver vein of Silver Islet belongs to the Upper

Copper-bearing series, and although it has been worked to a depth of 150 feet below the surface, no trouble has yet been experienced from flooding. Up to the middle of last summer about one million dollars' worth of silver has been taken from this mine. Various other silver-bearing veins and mines in rocks of this age were described briefly, but the space at our disposal will only allow of the bare mention of their names. Suffice it to say that the Algoma, Silver Harbor, Thunder Bay Silver mine, Shuniah, Jarvis Island, McKellar's Island and McKellar's Point deposits were each noticed. In conclusion the lecturer said that the silver veins which intersect trappean rocks belong to two sets, one of which have a N. E. and the other a N. W. direction.

At the close of the lecture a large number of specimens of the rocks of the district in question were exhibited and their peculiarities explained by Prof. Bell.

Mr. A. R. C. Selwyn brought for comparison a series of gold-bearing rocks from Australia. Some of these were evidently of Lower Silurian age, and contained graptolites, &c.

Mr. C. Robb asked whether the Silver Islet dyke had anything to do with the metalliferous character of the vein at that place.

Prof. Bell said the popular notion was that it had, but that the trials which had been made on other veins crossing the dyke did not support this view. The dyke is peculiar in its composition and contains a number of metals.

In the course of the discussion which followed, Mr. Bell suggested that if it were desirable to have a shorter name for the Upper Copper-bearing series of Lake Superior, we might adopt that of the Nipigon Group.—J. F. W.—(*Montreal Gazette.*)

NATIVE IRON DISCOVERED BY NORDENSKIÖLD IN GREENLAND.—The masses of native iron discovered in 1870 by Nordenskiöld at Ovifak in Greenland are especially interesting; for while on the one hand their mode of occurrence would lead one to consider them as terrestrial, their chemical constitution, though on the whole different from that of ordinary meteoric iron, in some respects, comes so near to it as to give some ground for considering them as extra-terrestrial. Specimens have been examined by Nordenskiöld, Wöhler, Daubrée and Berthelot.

The following is an abstract in a recent number of the Journal of the Chemical Society of a paper on the subject by A. Daubrée (Compt. rend., lxxiv, 1543–1550):

"In 1870 Nordenskiöld discovered at Ovifak, in Greeland, fifteen huge masses of native iron, of which one block, calculated to weigh at least 20,000 kilograms, is supposed to be the largest specimen of native iron on record. The whole were found within an area of 50 square meters. A basaltic rock, in close proximity to the masses, contained many fragments of metallic iron, and the detached blocks were also partially encrusted with a rock of similar character; there would appear to be no doubt but that the iron in the two situations was of identical origin.

"Nordenskiöld submitted portions of the iron to analysis, and found it to contain both nickel and cobalt: from this circumstance he concluded that it was of extra-terrestrial origin. Wohler, who also examined it, was of the same opinion. It must be admitted, however, that the intimate association of the iron with large eruptive masses in the neighbourhood tends to throw considerable doubt upon the accuracy of these conclusions. Several large specimens of iron from both sources were presented to the author, one of which he has carefully examined.

"This specimen was of a deep grey colour, almost black, resembling magnetite or graphitic cast-iron. It had a distinct cleavage, but the faces were not regular, and no distinct crystalline system could be seen. It was not ductile, but broke under the hammer, giving a dark brown-red powder, which was strongly attracted by the magnet. On a polished surface a want of uniformity in structure was observable, the brilliant white crystals of schreibersite and brass-yellow crystals of troilite being distinctly visible. At other places the presence of silicates produced deep green lithoïdal patches upon the surface. When treated with cold water the powder yielded a small percentage of sulphate and chloride of calcium with a trace of ferric chloride; in this respect the present specimen differs from an ordinary meteorite, in which the occurrence of calcium chloride has not been previously observed.

"The following are the results of a complete analysis:—

Iron, metallic	40·94
Iron, combined with O, S, and P	30·15
Carbon, combined	3·00
Carbon, free	1·64
Nickel	2·65
Cobalt	0·91
Oxygen	12·10
As, S, P, Si, Cu, H_2O, &c	8·61
	100·00

"At the author's request Berthelot examined the same sample. He found that on ignition it gave off a certain quantity of carbon monoxide and dioxide, but that no gaseous hydrocarbons were evolved. He also carefully examined it for graphite, but found none."

"These masses of iron from Ovifak are remarkable, not only from their large dimensions, but also from their chemical constitution, in which latter point, as well as in other physical characters, they are totally distinct from the general type of meteorites as at present known. The sharpness of the crystals of the silicates contrasts strongly with the confused crystallisation common in meteorites, to such an extent indeed that it is even possible to detect the cleavage and crystalline form characteristic of certain felspars, and by the aid of the microscope and polarized light to recognize an arrangement of the crystals such as is seen in labradorite ahd some varieties of dolerite. Again, the large quantity of soluble salts and calcium sulphate is another distinctive character, as is also the fact that, although in meteorites, the iron is frequently combined with sulphur, phosporus, &c., it is rarely if ever combined directly with oxygen, which latter is, in the present instance, the principal form of combination of the iron. This circumstance, as well as the presence of carbon, both free and combined, allies these specimens to the minerals known as carbonaceous meteorites.

"On the other hand, they differ still more widely from terrestrial species, such as dolerites and basalts, more especially since they contain nickel, cobalt, and ferrous sulphide.

"The author is inclined to think that these masses of iron are not of meteoric origin, but that they have been formed from basaltic rock, and erupted from exceptionally great depths. These basaltic rocks frequently contain as much as 20 per cent. of ferric oxide, and it is not impossible that during their passage to the surface, this oxide may have been partially reduced to the metallic state; at all events, such a supposition would account for most of the phenomena observed. This reduction would be especially probable in Greenland, where large deposits of lignite occur, and the presence of carbon in the masses might perhaps be accounted for in a similar manner. Against this must be set the fact that these specimens contain matter which decomposes or volatilises at a very moderate heat, which would be incompatible with their passing through such a highly heated region, as the presence of crystallised and anhydrous silicates would seem to imply.

"It has been noticed by Stammer and others that carbonic oxide, in presence of iron or iron oxide, produces, under certain circumstances, a deposit of carbon, of which a certain portion combines directly with the iron.

"This reaction the author has endeavoured to utilise as a synthetical method, not so much with the intention of preparing artificial meteorites, as to be enabled, by studying the phenomena which occur, to explain perhaps more satisfactorily the circumstances which attend the natural formation of masses of native iron."

BOTANY AND ZOOLOGY.

Genera Lichenum: An Arrangement of the North American Lichens. By Edward Tuckerman, M.A., Professor of Botany in Amherst College. Amherst, 1872.—Many of our most industrious botanists have neglected the lower forms of plant life. Possibly this is as much the result of the want of sufficient books of reference and of authentic collections, easily accessible, as of the greater patience and discrimination required in studying the lower organisms. Notably the Lichens have failed to excite enthusiasm: and yet how common and how conspicuous many of them are! The bare rock where no other life could thrive is often decked with variously coloured Lichens: on the ground amid the moss and on the old decaying stumps which too often stud the Canadian fields they are met with: our old palings have their coatings of them, dry and crisp; and parasitic-like they roughen the bark of almost every tree. Fortunately for science in America they have not been altogether overlooked. We have long known that Professor Tuckerman, of Amherst College, has made them a subject of special study, and to him botanists from various parts of North America have sent their collections for determination or criticism. Anything from his pen is sure to evince great care and unsparing labour, and the volume before us, the result of long and patient study of these collections, is no exception. In the preface he in brief tells us that the work is "a final report to the friendly correspondents of the author on the specimens which for many years they have sent to him for determination; and such determination implying a certain arrangement, the book is a further report upon what, after much labour, has commended itself to him as the best ascertained systematic disposition of the Lichens."

The value of spores in the determination of genera and species is now well known, though minor distinctions depending on size, septation, and the number of spores in each spore-case have by some authors been allowed too much weight. Professor Tuckerman's views on this subject, which first appeared in a pamphlet published in 1866, on Lichens of California, Oregon and the Rocky Mountains, are that "analysis scarcely indicates more than two well defined kinds of Lichen spores, complimented, in the highest tribe only, by a well defined intermediate one. In one of these (typically colourless) the originally simple spore, passing through a series of modifications, always in one direction and tending constantly to elongation, affords at length the *acicular* type. To this is opposed (most frequently, but not exclusively in the lower tribes, and even possibly anticipated by the polar bilocular sub-type in *Parmeliacei*) a second (typically coloured) in which the simple spore, completing another series of changes, tending rather to distention and to division in more than one direction, exhibits finally the *muriform* type." A consideration of these spore and other distinctions has led to considerable changes in the grouping of the species. A critical reference to these would interest the working lichenologist rather than the general student, and in this place we therefore need not more than say that the whole of these little organisms are, in the work before us, divided into five tribes whose characters are dependent chiefly on the external structure of the apothecium. These are sub-divided into families under which the genera are arranged. Beyond this, it will be sufficient to instance the changes in two familiar genera—the *Parmelia* of the old books, which is separated into *Theloschistes*, *Parmelia* and *Physcia* : and *Lecanora* which now becomes *Placodium*, *Lecanora* and *Rinodina*.

The book is replete with elaborate critical notes on the tribes, families, genera and species ; several new species, some of which are of interest to Canadians as occurring here, are incidentally described or referred to ; and what is of value in connection with the subject of geographical distribution, the range of species on this continent is frequently indicated.

Prof. Tuckerman's labours have been purely scientific. There is not perhaps very much in the book to attract the general scientific reader, but among those who make the Lichens their study this volume will be much appreciated.—A. T. D.

LARVÆ OF WORMS AND ECHINODERMS.—In a recent memoir in the Transactions of the American Academy, Alexander Agassiz, shews that certain larvæ named *Tornaria*, supposed to belong to star-fishes, are really young worms of the genus *Balanoglossus*. This, in his judgment, tends to destroy the slender basis of embryological resemblance on which Huxley had endeavoured to separate Echinoderms from other radiates and place them with certain worms in the so-called sub-kingdom Annuloida. If this is really so, it will tend to remove a perplexing anomaly of classification which has already found its way into many text books of Zoology and Palæontology.

CHEMISTRY.

RUBIDIUM IN BEETROOT.—The average composition of the ash obtained from the beetroots of the North of France is the following:

Potassium carbonate	30 per cent.
Sodium carbonate	20 " "
Potassium chloride	18 " "
Potassium sulphate	9 " "
Insoluble matter and moisture	23 " "

Besides these substances, small quantities of iodine and bromine, and of rubidium, are contained in the ash. The above substances may be separated by crystallization, or the potassium salts may be utilized first by converting them into the chloride and then into nitrate, by addition of sodium nitrate. After the separation of the greater portion of these salts by evaporation, &c., the rubidium may be precipitated from the diluted mother-liquor by addition of dilute solution of platinic chloride, or better by addition of a hot saturated solution of a potassio-platinic chloride. The precipitate obtained may be freed from the potassium salt by washing with water, and then reduced in a current of hydrogen. The author (E. Pfeiffer) estimates that ash from the beetroot of the North of France contains about 1.75 grm. of rubidium chloride to the kilogram of ash. From this it follows that 1 hectare of land yields about 255 grains of rubidium chloride to every crop of beetroot. The rubidium chloride contained a trace of caesium, but no lithium was found in the ash. Tobacco from the same region contains potassium, rubidium, and lithium and traces of sodium, whilst rape-seed contains only potassium and sodium, but neither rubidium nor lithium.—*Abstract in Jour. "Chem. Soc."*

GOLD IN SEA-WATER.—According to E. Sonstadt, the presence of gold in sea-water can readily be detected by several methods, although occuring in the very minute proportion of less than one grain to the ton. The solution of the gold is due to the presence of iodine, which, as Sonstadt showed some time ago, is liberated from the iodate of calcium existing in sea-water by the action of putrescible organic matter. The methods employed by Sonstadt for the detection of the gold are exceedingly interesting and ingenious. According to the first method, he operates upon 150 or 200 cubic centimetres of water. Two or three decigrammes of ferrous sulphate are dissolved in the water, which is made acid by the addition of two or three drops of hydrochloric acid. The solution is then heated in a glazed porcelain dish over a small flame, which is so arranged as to touch the under part of the dish, but should not produce ebullition. By this means a lustrous film of ferric oxide is deposited upon the bottom of the dish. The heat is kept up as long as the film increases, and the remaining liquid then poured off, the film washed with a little water, and 50 c. c. of strong chlorine water allowed to stand in the dish for an hour or two, and then evaporated down to a few drops, a drop of dilute hydrochloric acid being added towards the close of the evaporation. The liquid, which should be nearly colourless, is now poured into a test-tube containing a few drops of a solution of stannous chloride, and after a few minutes the liquid takes a bluish or purplish tint. The reaction is of course more distinct when larger quantities of water are used. Sonstadt says that he has sometimes failed to obtain the film of ferric oxide, but has been most successful when after the addition of the ferrous sulphate and hydrochloric acid to the water he has allowed the solution to stand for some hours exposed to the air.

In his second method he takes from half a litre to a litre of sea-water, and after adding sufficient barium chloride to produce about a grain of precipitate, allows the whole to stand for a day or two. The precipitate is then collected, dried, and after mixing with borax and lead, treated before the blow-pipe on charcoal and finally cupelled. In this way a yellowish-white button is obtained, having about the colour of an alloy of 60 parts of gold and 40 of silver. For the sake of confirmation, the button may be dissolved in a few drops of aqua regia and the solution evaporated nearly to dryness. A few drops of hydrochloric acid are now added, and the solution again evaporated in order to destroy the excess of nitric acid. When nearly to dryness a few drops of water are added, the mixture warmed, and, as soon as the argentic chloride has settled, a drop of solution of stannous chloride allowed to run down the side of the tube into the liquid, when the characteristic gold reaction is obtained.

The precipitation of the gold by barium chloride is curious, and explicable according to Sonstadt only "by supposing the gold to be present in the sea-water as an aurate, so as to be thrown down as aurate of barium. This view has much in its favour, and is greatly supported by the fact that if oxalic acid is added to sea-water some time before the addition of chloride of barium it is scarcely possible to detect gold in the precipitate formed. And this is easily to be understood, since oxalic acid reduces all gold salts."

Sonstadt even goes so far as saying that it is conceivable that the method of precipitation with barium chloride might be employed upon the large scale, by receiving the water at high-tide in large tanks and adding solution of barium chloride, the precipitate being removed from time to time, during low-tide.

The third method described by Sonstadt consists in the addition of a few grammes of ferrous sulphate to a litre of sea-water, this being followed in a few days by the addition of solutions of stannous and mercuric chlorides. Mercury is thus precipitated, and as it subsides carries down the gold and silver in the form of an amalgam. "This method is open to objection, as being more troublesome than the preceding methods." For further details the reader is referred to the original article in the *Chemical News*.

OBITUARY.

ADAM SEDGWICK.

Geology has lost her veteran leader! While yet firm in intellect, full of kind and generous feeling, and occupied on the last pages of the latest record of his labours, in the ninth decade of a noble life, Sedgwick has gone to his rest. Under the shadow of this great loss we look back through more than half a century, and behold no more conspicuous figure in the front ranks of advancing geology than the strenuous master workman, the eloquent teacher, the chivalrous advocate of science, who has now finished his task. Severe illness, borne with fortitude, had gradually withdrawn him from scenes once brightened by his ever-welcome presence, but could not tame the high spirit, or cloud the genial sympathies which had won for him, more than for other men, the loving admiration of his fellows in age and followers in study. Rarely has a patriarchal life been crowned with such enduring and affectionate respect.

Born in 1785, of a family long resident in a secluded Yorkshire Valley under the shadow of Wharnside, the boy early acquired the hardy habits and imbibed the free spirit of the north, and the man retained till his latest hour, a romantic love of the bold hills and rushing streams, amidst which he first became an observer of nature. Every homestead and every family in his native dale of Dent were treasured in his memory, and one of the latest of his minor literary essays was to plead against the change of the ancient name of a little hamlet situated not far from his birth-place.

Educated under Dawson, at the well-known school of Sedbergh, while Gough and Dalton were residing at Kendal, he proceeded to the great college in Cambridge, to which Whewell, Peacock, and Airy afterwards contributed so much renown. Devoted to the Newtonian philosophy, and especially attracted by discoveries then opening in all directions in physical science, he stood in the list as fifth wrangler, a point from which many eminent men have taken a successful spring. He took his degree in 1808, became a fellow in 1809, was ordained in 1817, and for some years occupied himself in the studies and duties of academic life. His attention to geology was speedily awakened, and became by degrees a ruling motive for the long excursions, mostly on horseback, which the state of his health rendered necessary in the vacations.

It was not, however, so much his actual acquirements in geology as the rare energy of his mind, and the habit of large thought and expanding views on natural phænomena, that marked him out as the fittest man in Cambridge to occupy the Woodwardian chair vacated by Hailstone. Special knowledge of rocks and fossils was not so much required as a well-trained and courageous intellect, equal to encounter theoretical difficulties and theological obstacles which then impeded the advance of geology.

The writer well remembers, at an evening *conversazione* at Sir Joseph Banks's, to which, as a satellite of Smith, he was admitted at eighteen years of age, hearing the remark that the new professor of geology at Cambridge promised to master what he was appointed to teach, and was esteemed likely to do so effectually. In the same year Buckland, his friendly rival for forty years, received his appointment at Oxford, where he had previously begun to signalize himself by original researches in palæontology.

At this time the importance of organic remains in geological reasoning, as taught by Smith, was not much felt in Cambridge, where a new born mathematical power opened out into various lines of physical research, and encouraged a more scientific aspect of mineralogy, and a tendency to consider the phænomena of earth-structure in the light of mechanical philosophy. This is very apparent in the early volumes of the Cambridge Philosophical Society, established in 1819, with Sedgwick and Lee for secretaries. Accordingly, the earliest memoirs of Sedgwick, which appear in the Cambridge Transactions for 1820–21, are devoted to unravel the complicated phænomena of the granite, killas, and serpentine in Cornwall and Devon; and to these followed notices of the trap-dykes of Yorkshire and Durham, 1822, and the stratified and irruptive greenstones of High Teesdale, 1823–24. In his frequent excursions to the north he was much interested in the varying mineral characters and fossils of the magnesian limestone, and the remarkable nonconformity of this rock to the subjacent coal, millstone grit, and mountain limestone; and at length his observations became the basis of that large systematic memoir which is one of the most valuable of the early contributions to the Transactions of the Geological Society. Begun in 1822 and finished in 1828, this essay not only cleared the way to a more exact study of the coal formation and New Red sandstones of England, but connected them by just inference with the corresponding deposits in North Germany, which he visited for the purpose of comparison in 1829.

To one of the equestrian excursions the writer was indebted for his first introduction to Sedgwick. In the year 1822 I was walking across Durham and North Yorkshire into Westmoreland. It was hot summer-time, and after sketching the High Force, in Teesdale, I was reclining in the shade, reading some easily carried book. There came riding up, from Middleton, a dark-visaged, conspicuous man, with a miner's boy behind. Opposite me he stopped, and courteously asked if I had looked at the celebrated waterfall which was near; adding that though he had previously visited Teesdale, he had not found an occasion for viewing it; that he would like to stop then and there to do so, but for the boy behind him, "who had him in tow to take him to Cronkley Scar," a high dark hill right ahead, where, he said, "the limestone was turned into lump-sugar."

A few days afterwards, on his way to the lakes, he rested for a few hours at Kirby Lonsdale to converse with Smith, who was engaged on his geological map of the district, and had just discovered some interesting fossils in the laminated strata below the Old Red sandstone, on Kirkby Moor, perhaps the earliest observation of shells in what were afterwards called the upper Ludlow beds. The two men thus brought together were much different, yet in one respect alike: alike in a certain manly simplicity, and unselfish communion of thought. Eight years after this Adam Sedgwick was President of the Geological Society, and in that capacity presented to William Smith the first Wollaston medal. The writer may be permitted the pleasure of this reminiscence, since from the day when he learned the name of the horseman in Teesdale, till within a few days of his death, he had the happiness of enjoying his intimate friendship.

Sedgwick had acquired fame before Murchison began his great career. After sharing in Peninsular wars, and chasing the fox in Yorkshire, the "old soldier" became a young geologist, and for many years worked with admirable devotion to his chief, and carried his banner through Scotland, and Germany, and across the Alps, with the same spirit as he had shown when bearing the colours for Wellington at Vimiera.

Important communications on Arran and the north of Scotland, including Caithness (1828) and the Moray Firth, others on Gosau and the eastern Alps (1829–1831), and still later, in 1837, a great memoir on the Palæozoic Strata of Devonshire and Cornwall, and another on the coeval rocks of Belgium and North Germany, show the labours of these intimate friends combined in the happiest way—the broad generalisations in which the Cambridge Professor delighted, well supported by the indefatigable industry of his zealous companion.

The most important work in the lives of these two eminent men was performed in and around the principality of Wales; Sedgwick, as might be expected, lavishing all his energies in a contest with the disturbed strata, the perplexing dykes, and the cleavage of the lowest and least understood groups of rocks; Murchison choosing the upper deposits exceptionally rich in fossils, and on the whole presenting but little perplexity as to succession and character. One explorer, toiling upward from the base, the other descending from the top, they came after some years of labour (1831 to 1835) in sight of each other, and presented to the British Association meeting in Dublin a general view of the stratified rocks of Wales.

Thus were painfully unfolded the Cambrian and Silurian systems, which speedily became, in a sense, the scientific property of the discoverers, and were supposed to be firmly separated by natural and unmistakeable boundaries. They were, however, not really traced to their junction, though Murchison stated that he had found many distinct passages from the lowest member of the Silurian system into the underlying slaty rocks named by Prof. Sedgwick the "Upper Cambrian;" while Sedgwick admitted that his upper Cambrian, occupying the Berwyns, was connected with the Llandeilo flags of the Silurian system, and thence expanded through a considerable portion of South Wales (Reports of Brit. Assoc., 1835). The Bala rocks were disclaimed on a cursory view by Murchison, the Llandeilo beds surrendered without sufficient examination by Sedgwick; thus the two kingdoms overlapped largely; two classifications gradually appeared; the grand volume of Murchison was issued; and then began by degrees a difference of opinion which finally assumed a controversial aspect, always to be deplored between two of the most truly attached and mutually helpful cultivators of geological science in England:—

> "Ambo animis, ambo insignes præstantibus armis."

This source of lasting sorrow to both, if it cannot be forgotten, ought to be only remembered with the tenderness of regret.

Familiar as we now are with the rich fauna of the Cambrian and Silurian rocks, and their equivalents in Bohemia and America, it is not difficult to understand, and we may almost feel again the sustained enthusiasm which welcomed the discoveries which seemed to reveal the first state of the sea, and the earliest series of marine life "primaque ab origine mundi," almost to complete the physical history of the earth. Starting with a general view of the structure of the Lake Mountains of the north of England, and the great dislocations by which they have been separated from the neighbouring chains (Geol. Proc. Jan. 1831). Sedgwick won his difficult way through North Wales to a general synopsis of the series of stratified rocks below the Old Red sandstone, and attempted to determine the natural groups and formations (Geol. Proc. May, 1838). Three systems were named in order—Lower Cambrian, Upper Cambrian, Silurian—the working out of which, stream by stream, and hill by hill, worthily tasked the energies of Ramsay and his friends of the National Survey for many useful years, after increasing ill-health had much reduced the field-work of the Professor.

But now he began to labour more earnestly than ever in the enlargement and setting in order of the collections which were under his personal charge. In 1818, these consisted almost wholly of the small series bequeathed by Dr. Woodward; now they have been expanded by the perpetual attention and generosity of Sedgwick, into one of the grandest collections of well-arranged rocks and fossils in the world. One of the latest acquisitions is the fine cabinet of Yorkshire fossils, purchased by Cambridge as a mark of loving respect for her great teacher in his fast decaying days.

In this work of setting in order a vast collection gathered from various regions, and from all classes of deposits, Prof. Sedgwick, with wise liberality, engaged the willing aid of some of his own pupils, and of other powerful hands brought to Cambridge for the purpose. Ansted, Barrett, Seely, M'Coy, Salter, Morris, have all helped in this good work, and to their diligence and acumen were added the unrivalled skill and patience of Keeping, one of the best "fossilists" in Europe. Those who in this manner have concurred in the labours of their chief, one and all found in him the kindest of friends, the most considerate of masters—one who never exacted from others, and always gave to his assistants more than the praise and the delicate attention which their services deserved.

The ample volumes entitled "British Palæozoic Rocks and Fossils, 1851–5," by Sedgwick and M'Coy, must be consulted for a complete view of the classification finally adopted by Sedgwick; and further information is expected from the publication of a Synoptic Catalogue, to which Salter gave some of his latest aid.

During his long tenure of a Fellowship in Trinity College, Prof. Sedgwick witnessed great changes in the mathematical training, and contributed as much as any man to the present favourable condition of Science in Cambridge.

To defend the University against hasty imputations, to maintain a high standard of moral philosophy, and a dignified preference for logical induction to alluring hypothesis was always in his thoughts. Hence the "Discourse on the Studies of the University of Cambridge," at first an eloquent sermon, grew by prefix and suffix to a volume which he himself likened to a wasp —large in front and large behind, with a very fashionable waist.

Under such feelings he spoke out against the "Vestiges of

Creation" with a fervour of argument and declamation which must have astonished the unacknowledged author of that once popular speculation. Nor was he silent when the views of Darwin came to fill the void places of biological theory, against which he not only used a pen of steel but made great use of his heavy hammer.

The vigour—vehemence we may call it—of his pen and tongue in a matter which touched his sense of justice, morals, or religion, might mislead one who did not thoroughly know his truth and gentleness of heart, to suppose that anger was mixed with his honest indignation; but it was quite otherwise. In a letter addressed to the writer, in reply to some suggestion of the kind, he gave the assurance that he was resolved "no ill blood" should be caused by the discussion which had become inevitable.

He never failed in courtesy to the honest disputant whose arguments he mercilessly "contunded." Taken altogether, Professor Sedgwick was a man of grand proportion, cast in a heroic mould. Pressed in early life through a strict course of study, he found himself stronger by that training than most of his fellow geologists, but never made them feel his superiority. Familiar with great principles, and tenacious of settled truths, he was ready to welcome and encourage every new idea which appeared to be based on facts truly observed, and not unprepared or unwilling to stand, even if alone, against what he deemed unfair objection or unsubstantial hypothesis.

This is not the place to speak of his private worth, or to indulge in reminiscence of his playful and exuberant fancy, the source of unfailing delight to those who knew him in his happier hours. Unmarried, but surrounded by plenty of cheerful relatives, his last hours of illness were soothed by sedulous affection; his kindly disposition no suffering could conceal; his lively interest in passing events nothing could weaken. Ever

"Against oppression, fraud, or wrong,
His voice rose high, his hand waxed strong."

With collected mind, on the verge of the grave, he would express, with undiminished interest, his latest conclusions on his own Cambrian system, purely as a matter of scientific discussion, free from all personal considerations. It will be well if this mode of treatment be reverently followed by those who while speaking of Protozoic and Palæozoic Rocks, know enough to feel how much they have been benefited by the disinterested labours of a long and noble life.—*From "Nature."*

THE

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IMPRESSIONS AND FOOTPRINTS OF AQUATIC ANIMALS AND IMITATIVE MARKINGS, ON CARBONIFEROUS ROCKS.*

By J. W. Dawson, LL.D., F.R.S.

The footprints and other markings of aquatic invertebrate animals and of fishes, are necessarily for the most part, less distinctive and important than those of land animals, both because less characteristic in themselves, and because reproduced under similar forms in very different geological periods. The former peculiarity has caused them to be neglected as of little importance, or to be confounded with impressions of plants. With reference to the latter, I have myself shown that the impressions made by the modern King-crab faithfully represent the *Protichnites*, *Climactichnites*, and *Rusichnites* of the Primordial and Silurian, and similar comparisons have been made by Salter, Jones, Dana and others, between the tracks of modern Crustaceans and worms and some of those in the oldest rocks.

1. *Protichnites*, Owen.

The footprints from the Potsdam Sandstone in Canada, for which this name was proposed by Owen, and which were by him referred to Crustaceans probably resembling *Limulus*, were shown by me in 1862† to correspond precisely with those of the American Limulus (*Polyphemus occidentalis*). I proved by experiment with the modern animal that the recurring series of groups of markings were produced by the toes of the large posterior thoracic feet, the irregular scratches seen in *Protichnites lineatus* by the ordinary feet, and the central furrow by the tail. It was also shown that when the Limulus uses its swimming feet it produces impressions of the character of those named *Climactichnites*, from the same beds which afford *Protichnites*. The principal difference between *Protichnites* and their modern representatives is that the latter have two lateral furrows produced by the sides of the carapace, which are wanting in the former.

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* *From Silliman's Journal.*

† *Canadian Naturalist*, vol. vii.

As Limuloid crustaceans are well known in the Carboniferous beds of Europe and America, their footprints might be expected to occur in rocks of this age, but the first I have met with were sent to me last summer by my friend Mr. Elder, of Harvard College, who found them quite abundantly in dark-colored flagstones belonging to the Millstone Grit formation at McKay's Head in Nova Scotia (fig. 1). The animal which produced these marks must have been of small size (about half an inch in breadth), in this agreeing with the usual size of the Coal-formation Limuloids; and like the ancient Protichnite-makers, it left no trace of the edges of the carapace, but a very distinct impression of a sharp pointed tail. Its posterior feet had three or possibly four sharp toes. There were besides several pairs of sharp-pointed walking feet. On the same slabs there are some series of marks, evidently made by the same kind of animal, which have no tail-mark, and there are tail-marks with only traces of those of the toes. It is worthy of notice that, though these tracks indicate the presence of the animal, no crusts of Carboniferous Limuloid crustaceans have yet been found in Nova Scotia. The sand in which the tracks now referred to were made was probably too hard to permit the swimming feet to make any impression. With respect to the absence of the marks of the sides of the carapace, I may observe that the genus *Belinurus* of the Carboniferous had the sides of the carapace less deep than that of the modern Limulus, and this may also have been the case with the more ancient Limuloids of the Potsdam. See as to this a letter by Prof. Hall in the *Canadian Naturalist*, 1862.

To Protichnites may perhaps be referred a very singular impression from Horton Bluff (fig. 2), which at first sight much resembles *P. Scoticus*, from the Primordial of Roxburghshire, though the Carboniferous specimen is larger and more complicated.* It seems to have been produced by the successive pressure of a pair of flat organs, crenated or toothed at the edges, rather than divided into separate toes. Its horizon is the Lower Carboniferous. It was collected by Prof. Hartt.

The first species of *Protichnites* referred to above may be appropriately named *P. Carbonarius*, and the second *P. Acadicus*. They are, I believe, the first impressions of this kind found in the Carboniferous.

2. *Rusichnites*, Dawson.

In a paper published in the *Canadian Naturalist*, 1864, I showed that the singular bilobate markings with transverse striæ named *Rusophycus* by Hall, and found in the Chazy of Canada and the Clinton group of New York, are really casts of burrows connected with footprints consisting of a double series of transverse markings, and that a comparison of them with the trails and burrows of Limulus justified the conclusion that they were produced by Trilobites. I proposed for these and for similar impressions of small size found in the Carboniferous, the name given above. The Carboniferous examples I supposed might have been produced by the species of *Phillipsia* found in these beds. A specimen recently obtained from Horton shows this kind of impression passing in places into a kind of Protichnites, as if the creature possessed walking feet as well as the lamellate swimming feet which it ordinarily used.

I can scarcely doubt that the *Cruziana semiplicata* of Salter, and *C. similis* of Billings from the Primordial of Newfoundland, must have been produced by crustaceans not dissimilar from those to which *Rusichnites* belongs.

To *Rusichnites* rather than to *Protichnites* ought perhaps to be referred certain transverse linear impressions with a broad central groove from the Lower Carboniferous of Horton, which occur at that place under different modifications, and sometimes seem to change into light scratches or touches of feet employed in swimming, or end abruptly as if the animal had suddenly risen from the bottom.

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* Siluria, 4th edition, p. 153.

Arenicolites, Salter.

This genus may be held to include cylindrical burrows of worms with or without marks of minute setæ. They occur in rocks of all ages, and are especially abundant in the Lower Carboniferous series of Half-way River, Nova Scotia, and in the Upper Coal-formation at Tatamagouche in the same province; those at the latter place showing minute scratches produced by the setæ of the worms.* With the ordinary form at Horton there occur very long and slender, thread-like forms of the same nature with those to which the name *Nemertites* has been given.

I have long been of opinion that many of the cylindrical markings which have been described as plants under the names *Palæochorda*, *Buthotrephis*, *Palæophycus*, *Arthrophycus*, &c., are burrows of this kind, but the main difficulty seemed to be to account for their branching in a radiate or palmate manner. I have recently met with specimens from the Primordial and Carboniferous which seem to explain this. They show a central hole or burrow from which the animal seems to have stretched and withdrawn its body in different directions, so as to give an appearance of branching and radiation, possibly due merely to the excursions of the same worm from the mouth of its burrow.

No distinct examples of the Primordial and Silurian worm-trails known as *Nereites*, *Myrianites* and *Crossopodia*, have yet occurred to me in the Carboniferous.

Diplichnites, Dawson.

In the Journal of the Geological Society for 1861, I described a remarkable series of impressions found at the Joggins in the Coal-formation, on the surface of a sandstone holding footprints of reptiles. It consists of two rows of strongly marked depressions about one inch long and a quarter of an inch broad (fig. 3). These marks are placed close together in each row, and the rows are six inches apart, while the space between is somewhat smoothed as if by a flat body drawn over it. The general appearance is somewhat that which would be produced by a heavy-laden toy cart six inches wide, and with broad wheels, notched or cogged at the edges, if dragged over firm sand. I suggested, in the paper above mentioned, that these singular markings might have been produced by a large crustacean or by a gigantic worm, or by a serpentiform batrachian. I have since found a very perfect but smaller series on a sandstone of the Upper Coal-formation near Toney river, which in the varying distances of the impressions seems to show that they were made by prominent movable points, while the absence of any mark or smoothing between the rows shows that the body of the animal was borne above the sand. I have hence been induced to suppose that these imprints may have been produced by the pectoral or ventral fins of fishes armed with strong spines, on which the creatures may have executed a sort of walking movement when in shallow water. In my collection from the Joggins there is a spine which I have figured and described in my Acadian Geology under the name *Gyracanthus duplicatus*, which if we can suppose it to have been a pectoral or ventral spine, would produce precisely such impressions as those of the smaller series above mentioned. The impressions of the type of *Diplichnites* are known to me only in the Carboniferous. *Sœrichnites* of Billings, from the Anticosti group,* has some points of resemblance to it, but is essentially distinct. My species may be named *D. œnigma*.

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* Journal of the Geological Society, vol. ii.

Rabdichnites, Dawson.

Under this name I would designate the straight or slightly curved marks usually striated or grooved longitudinally, and either single or in pairs, which abound on some Carboniferous beds, and also in much older formations. At Horton Bluff, in beds holding remains of fishes, numerous footprints of crustaceans and reptiles, and scratches which were probably made by the fins of fishes, these marks abound. They were evidently furrows drawn by pointed objects trailed over the mud, and reproduced in relief on the under surfaces of the beds next deposited. Some have been produced by rounded points and are semi cylindrical. Others are the work of chisel-shaped, pointed, notched or fimbriated organs, giving a variety of more or less close subordinate grooves or striæ. In some cases they pass into or are associated with punctures or impressions made perpendicularly like those last noticed, and this is especially the case with some of the smaller varieties. The whole of these impressions are probably marks of the spines and fins of fishes, striking the bottom or trailed over it. Some of the beds at Horton Bluff are as completely striated in this way as if glaciated, only that the striæ are individually more definite and are in all directions.

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* Report on Silurian Fossils of Anticosti, 1866.

It is worthy of note that these markings strikingly resemble the so-called *Eophyton* described by Torell from the Primordial of Sweden, and by Billings from that of Newfoundland; and which also occurs abundantly in the Primordial of New Brunswick. After examining a series of these markings from Sweden shown to me by Mr. Carruthers in London, and also specimens from Newfoundland, and a large number *in situ* at St. John, I am convinced that they cannot be plants, but must be markings of the nature of Rabdichnites. This conclusion is based on the absence of Carbonaceous matter, the intimate union of the markings with the surface of the stone, their indefinite forms, their want of nodes or appendages, and their markings being always of such a nature as could be produced by scratches of a sharp instrument. Since, however, fishes are yet unknown in beds of this age, they may possibly be referred to the feet or spinous tails of swimming crustaceans. Salter has already suggested this origin for some scratches of somewhat different form found in the Primordial of Great Britain. He supposed them to have been the work of species of *Hymenocaris*. These marks may, however, indicate the existence of some free-swimming animals of the Primordial seas as yet unknown to us.

Three other suggestions merit consideration in this connection. One is that algæ and also land plants, drifting with tides or currents, often make the most remarkable and fantastic trails. A marking of this kind was observed by Mr. G. M. Dawson last summer to be produced by a Laminaria, and in complexity it resembled the extraordinary *Ænigmichnus multiformis* of Hitchcock from the Connecticut sandstones. Much more simple markings of this kind would suffice to give species of *Eophyton*. Another is furnished by a fact stated to the author by Prof. Morse, namely, that Lingulæ, when dislodged from their burrows, trail themselves over the bottom like worms, by means of their cirri. Colonies of these creatures, so abundant in the Primordial, may, when obliged to remove, have covered the surfaces of beds of mud with vermicular markings. The third is that the Rabdichnite-markings resemble some of the grooves in Silurian rocks which have been referred to trails of Gasteropods, as for instance, those from the Clinton group, described by Hall.

An might be expected, the markings above referred to, when in relief, occur on the under sides of the beds. A few instances may, however, be found where they exist on the upper surfaces. On careful consideration of these raised impressions, I have arrived at the conclusion that they have been left by denudation of the surrounding material, just as footprints on dry snow sometimes remain in relief after the surrounding loose snow has been drifted away by the wind; the portion consolidated by pressure being better able to resist the denuding agency. Such markings in relief on the upper surfaces of beds are, however, I believe, altogether exceptional.

It seems idle to give specific names to markings of this kind. They have evidently been made by many different species of animals, but they afford no certain characters. Fig. 4 *a* to *f*, represents some of the forms most common in the Carboniferous beds.

Imitative markings.

Rill-marks are often very beautifully developed on the Carboniferous shales and argillaceous sandstones, though not more elaborately than on the modern mud-banks of the Bay of Fundy,* and they occur as far back as the oldest Cambrian.† Some of these simulate leaves of ferns and fronds of Laminariæ, and others resemble roots, fucoids allied to Buthotrephis, or the radiating worm-burrows already referred to.

Shrinkage cracks are also abundant in some of the Carboniferous beds and are sometimes accompanied with impressions of rain-drops. When finely reticulated they might be mistaken for the venation of leaves, and when complicated with little rill-marks tributary to their sides, they precisely resemble the Dictuolites of Hall from the Medina Sandstone.

An entirely different kind of shrinkage-crack is that which occurs in certain carbonized and flattened plants, and which sometimes communicates to them a marvellous resemblance to the netted under-surface of an exogenous leaf (fig. 5). Flattened stems of plants and layers of cortical matter, when carbonized, shrink in such a manner as to produce minute

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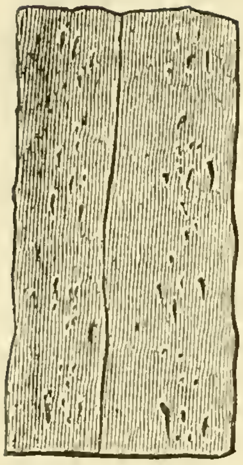
* Acadian Geology, 2nd edition, p. 26.

† Salter, Journal of Geol. Society, vol. 12, p. 251.

1.



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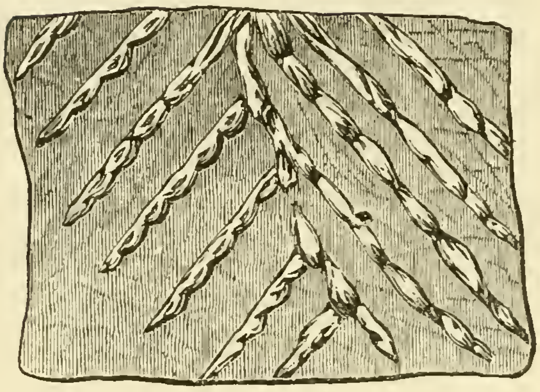

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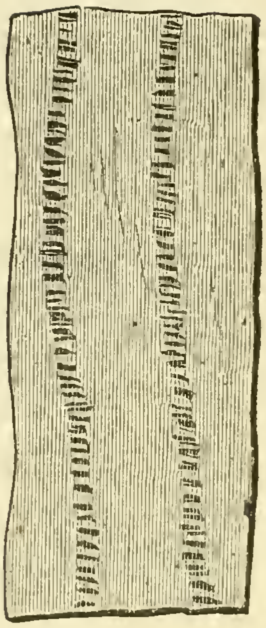
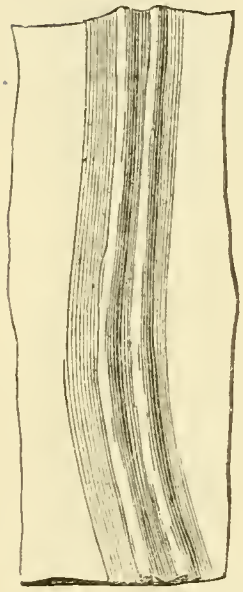
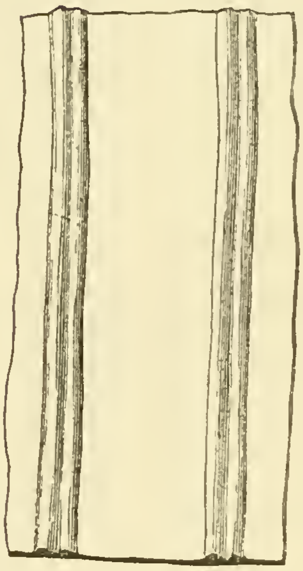


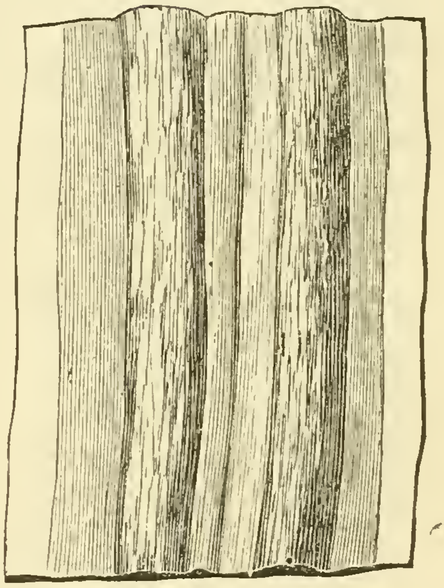
4 *a*



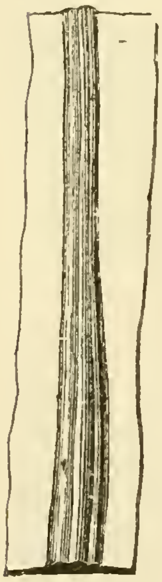
4 *c*



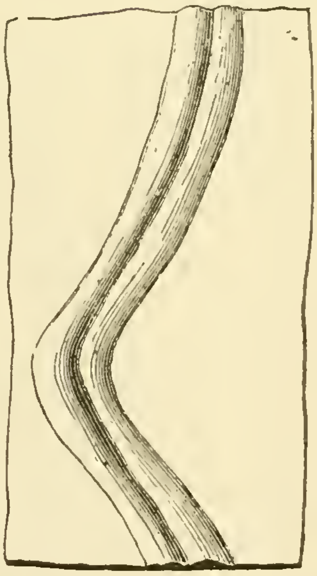
4 *d*



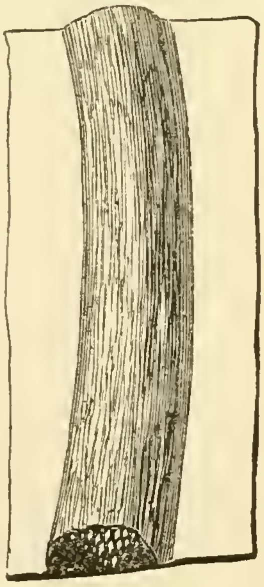
4 *b*



4 *e*



4 *f*



5.

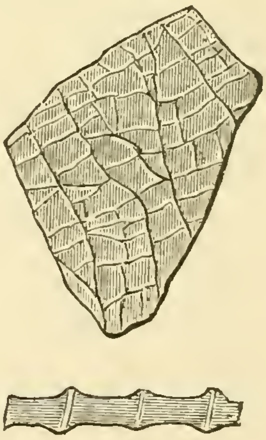


Fig. 1.—*Protichnites Carbonarius* (nat. size). Carboniferous, Nova Scotia.
Fig. 2.—*P. Acadicus*, " " "
Fig. 3.—*Diplichnites ænigma* (reduced). " "
Fig. 4.—*Rabdichnites*, different forms (nat. size). " "
Fig. 5.—Carbonized plant with reticulated markings (nat. size); *a*, enlarged section of part of the same. Carboniferous, Nova Scotia.

reticulated cracks. These become filled with mineral matter before the coaly substance has been completely consolidated. A further compression occurs, causing the coaly substance to collapse, leaving the little veins of harder mineral matter projecting. These impress their form upon the clay or shale above and below, and thus when the mass is broken open we have a carbonaceous film or thin layer covered with a network of raised lines, and corresponding minute depressed lines on the shale in contact with it. The reticulations are generally irregular, but sometimes they very closely resemble the veins of a reticulately veined leaf. One of the most curious specimens in my possession was collected by Mr. Elder in the Lower Carboniferous of Horton Bluff. The little veins which form the projecting network are in this case white calcite; but at the surface their projecting edges are blackened with a carbonaceous film.

Slicken-sided bodies, resembling the fossil fruits described by Geinitz as *Gulielmites*, and the objects believed by Fleming and Carruthers[*] to be casts of cavities filled with fluid, abound in the shales of the Carboniferous and Devonian. They are, no doubt, in most cases the results of the pressure and consolidation of the clay around small solid bodies, whether organic, fragmentary or concretionary. They are, in short, local slicken-sides precisely similar to those found so plentifully in the coal underclays, and which, as I have elsewhere[†] shown, resulted from the internal giving way and slipping of the mass as the roots of Stigmaria decayed within it. Most collectors of fossil plants in the older formations must, I presume, be familiar with appearances of this kind in connection with small stems, petioles, fragments of wood, and carpolites. I have in my collection petioles of ferns and fruits of the genus *Trigonocarpum* partially slicken-sided in this way, and which if wholly covered by this kind of marking could scarcely have been recognized. I have figured bodies of this kind in figs. 126 and 231 of my report on the Devonian and Upper Silurian plants, believing them, owing to their carbonaceous covering, to be probably slicken-sided fruits, though of uncertain nature. In every case I think these bodies must have had a solid nucleus of some sort, as the severe pressure implied in slicken-sliding is quite incompatible with a mere "fluid-cavity," even supposing this to have existed.

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[*] Journal of Geol. Society, June, 1871.

[†] Ibid, vol. x, p. 14.

Prof. Marsh has well explained another phase of the influence of hard bodies in producing partial slicken-sides, in his paper on *Stylolites*, read before the American Association in 1867, and the application of the combined forces of concretionary action and slicken siding to the production of the cone-in-cone concretions, which occur in the Coal-formation and as low as the Primordial, was illustrated by the author in his Acadian Geology, p. 676.

Of course, as I have not seen the specimens referred by Prof. Geinitz to *Gulielmites*, but only the figures in his Memoir on the Permian plants of Saxony, I cannot offer any decided opinion as to their nature; but I have little doubt that the bodies mentioned by Mr. Carruthers are of the kind above referred to, and would be found to have had a solid nucleus either organic or of some other kind.

I may remark in conclusion that it would be well if collectors would give some attention to imitative markings and animal footprints of the kinds above referred to, as well as to their mode of occurrence with reference to the surfaces and material of the beds on which they are found. The labors of Duncan, Hitchcock, Jardine, Salter, and other careful observers, show how much interesting information may thus be obtained, and many mischievous errors might also be avoided. In my own studies in fossil botany, I have made it a point to collect and study all markings resembling plants, as well as the effects of crumpling, pressure, concretionary action, cyrstalization, shrinkage and slicken-siding upon actual vegetable remains; and by so doing I have avoided the trouble and expense of describing and figuring some dozens of imaginary species; while it would be easy to point out in works of some pretension costly figures and elaborate descriptions based on imitative forms or distorted and otherwise altered fossils.

IMPRESSIONS OF CUBA.

By G. F. Matthew.

(*Continued from page* 34.)

The plan of the houses in and about Cienfuegos is very different from that of our own, and a few words about their arrangement may be of interest. They are seldom more than one story high, and in the better class of houses the roofs are in almost all cases covered with tiles. I have already made allusion to the use made of the clay in the vicinity of Cienfuegos for the manufacture of tiles and bricks. The bricks are of a yellow color, and are much broader and flatter than those used in Canada: large quantities are used for the walls and floors of houses, for paving the sidewalks, &c.

The general arrangement of the apartment reminds one of the old Roman dwelling, modified to suit the requirements of the climate and the demands of modern civilization. In the centre is a paved court (*patio*) which corresponds to the *atrium* in being the heart of the structure. This court is usually adorned with flower-beds, a few ornamental trees and shrubs, and an aviary; and not unfrequently has beneath it a large cistern. In front of the court there is a closed veranda (*comodor,*) generally used as a dining and sitting room; and which is shut off from the court by latticed doors. On the sides of the court are bedrooms and store-rooms, while the back part of the building, which is shut off from the body of the house by a brick wall, is reserved for kitchen, laundry, &c. In the small court behind the main one are the apartments occupied by domestic slaves. In front of the veranda of which I have spoken, is the more substantial portion of the house, usually enclosed with brick walls, against which the veranda is built. In this part of the building there is on one side a very broad hall (*zaguan*), made so to accommodate the family carriage, which stands here when not in use. It is shut off from the street by a large, heavy door, in which is a wicket, the only entrance to the house under ordinary circumstances. On the other side of the main building is a large room (*sala*) devoted to the purpose of a parlour and drawingroom.

Both it and the hall are open to the roof, and it has usually two large windows opening to the street, secured by longitudinal iron bars and heavy wooden shutters. In a climate so warm as that of Cuba, one principal aim in the construction of houses is to make them as cool as possible. The windows and doors opening upon the court are accordingly closed only with Venetian shutters, and there are open spaces just beneath the eaves. The floors are of brick, stone-flagging, or marble, carefully laid, in order that no harbor may be afforded to the reptiles and vermin which abound in a warm climate.

In passing such a house in the day time, one finds the shutters closed, the great gate-like doorway fastened, and can see in it only the aspect of a prison. After nightfall, however, when the sea-breeze dies away, and the cool evening air settles around the town, Cienfuegos appears to wake up. The heavy shutters which hide the interior of the houses from view are thrown open, the rooms brilliantly lighted, and the passer-by is made acquainted with one phase in the social life of the Cubans. Within the parlour will be seen two rows of rocking-chairs arranged *vis-a-vis*. One row will be occupied by the ladies of the family, fan in hand, and in full dress; the other, reserved for any friends who may "drop in." These still, cool, balmy evenings are sure to find numbers of strollers and promenaders of both sexes in the streets. On Sundays and Thursdays there are gatherings of the townspeople in the evening on the *plaza*, or public square, to listen to operatic music from the band, and give opportunity for more general intercourse than is afforded by the more select meetings in private *salas*. On such occasions both ladies and gentlemen appear in full dress, the former with uncovered heads. Sunday is the gala-day of the week in this Island, and is chosen for public exhibitions and processions, theatrical entertainments and cock-fights, as well as for public and private balls.

While the evening hours bring into view the sociable and fashionable phase of Cuban life, a stroll through the streets in the early morning gives an insight into its devotional and domestic aspect. When the dew is scarcely off the ground, groups of females with their attendants may be observed wending their way toward the large double-gabled church on the side of the *plaza*. Such a group will consist of the *signora* and some of her daughters, accompanied by a black slave, who carries one or two stools for the ladies and a mat to kneel upon in church; for such accommodation as pews, to encourage exclusiveness and somnolency, are not thought of in this land, and those who will be luxurious, must protect themselves against the chill communicated from the bare stone floor, by mats or carpets of their own. Another centre of attraction at this early hour is the market. Hither go the dark-skinned domestics with their long, sack-like baskets of palm-leaf, to gossip, or make purchases. A Babel of tongues—if not for variety, at least for volubility—salutes the ear of one entering the building where the market is held, and a great deal more chaffering accompanies the purchase of a dinner, than a stolid and reticent Northerner would think necessary. Sweet potatoes and their gigantic relative the yam, are presented for sale in large quantities. Eggs and poultry seem favourite articles of diet; the poultry are always offered for sale alive, as a prudent housewife in Cuba would hardly venture to buy plucked fowls, on account of the heat of the climate. As I did not visit Cienfuegos during the fruit season, I saw little in market; bananas, with a few oranges, mameys and limes seemed the staple varieties. The fish offered for sale appear to be all of the spiny-finned orders (*Acanthopteryges*): of these the *Rubia*, a beautiful rose-colored fish, not unlike a perch in its form, seemed an especial favorite. There were also prawns, crabs and small oysters. There is a large restaurant near the market where the countrymen (*guajiros*) may be seen sipping their coffee, chocolate, or wine, at small tables distributed through the rooms. All appeared temperate and orderly, and there was no "bar."

In the early morning hours, too, one may see these same *guajiros*, mounted on horse or mule, hawking their charcoal and *maloja* (green fodder) through the streets. As one of them appears in the early dawn approaching the city, mounted on his beast, with a great pannier or bundle on either side, the group looks not unlike an inverted pyramid, moving quietly yet swiftly towards you, and yet maintaining its equilibrium by some magical power.

Another class, which one frequently meets with at this time of day, is the huxters, who traverse the city on foot, bringing supplies to the doors of those who cannot visit the market. Among these are a number of Chinamen, who having served out their apprenticeship on the estates, and having a shrewd eye to business, obtain a little stock of vegetables and fruit, which they cry about town; carrying their wares in trays suspended from the ends of a bamboo pole, resting on the shoulders—in true oriental fashion. They appear to be very thrifty and intelligent, but have other vices than opium-smoking, for they are avaricious and revengeful.

The Chinese very soon take a higher position on the estates than the negroes with whom they labor. They are generally to be found employed where delicate manipulation or higher intelligence is required. Thus they work in the sugar-houses, while the negroes are generally sent to the cane-fields. If there is any carpentry or masonry to be done on the estates, the Chinamen are the ones to do it; they are also frequently employed as landscape gardeners, and show much aptitude and originality in improving the surroundings of a planter's house. On a few estates some who have been long in the Island have risen to the responsible position of overseer of the sugar-house, receiving $2 to $3 per diem.

Negro field-hands are invaluable to the Cuban planters; for while the Chinamen have a bad trick of committing suicide when severely dealt with, the negro puts up with his hard lot, and works away, if not contentedly, at least with few attempts at open rebellion. Except for the tremendous labour exacted from them during the grinding-season, and the dependent position in which they are kept, the lot of the negro-bondsman in Cuba is one of considerable animal enjoyment, and is such as to subject him to few of the cares of life. He is well fed and housed, and his children well cared for. If he desires to acquire a few additional bodily comforts, a small patch of land is placed at his disposal for cultivation, and he is permitted to raise pigs and poultry on a small scale for sale—all this, however, during good behaviour. If he is restive, thievish, or lazy, he is deprived of the chance of attending to his little farm, and, from neglect, all his luxuries vanish. On the plantations, women, as well as men, are taken out to cut the cane, feed the crushers at the mill, and perform other work.

During the grinding season, which lasts four or five months, the slaves are required to work sixteen hours out of the twenty-four. After the canes are ground they are not usually required to work more than eight or ten hours a day. Planters often employ the farming population of the country in clearing new lands where cane is to be planted, thus saving their slaves from exhausting labor, and curtailing their chances for running away.

Oxen are extensively used as draft animals in Cuba. Large numbers are required on an estate for ploughing the cane-fields, carrying the canes to mill when they are cut, and transporting the produce of the estates to market, or places of shipment. The Cuban oxen are about the size of our own: they are frequently dun-colored or brown, and trot with ease and rapidity. Seeing the swiftness with which they go over the estate roads, with a heavy cart behind them, one can appreciate better the value of the ox as a saddle animal in regions where horses cannot live, and can understand the luxury of riding "ox-back" in South Africa. Horses are reserved almost entirely for the saddle and the carriage. A Cuban farmer, let him be ever so poor, must have his horse to ride.

The view of a Cuban plantation with its fields of bright green cane extending for furlongs, sometimes miles, on every side of the single cluster of estate buildings, is a sight which, once seen, is not easily forgotten. As the dry season is not long enough to work up the whole crop of a plantation, the "grinding season" begins before the canes are ripe. The immature canes first cut are deficient in saccharine matter, and the juice obtained from them is seldom boiled down to sugar, but is generally converted into molasses: the article thus obtained is a rich heavy syrup, far superior to the common molasses obtained by drainage from the sugars. The process of sugar-making begins with the sending of one or more gangs of negroes to the cane-field, each accompanied by an overseer on horseback, whip in hand. Each field-hand is armed with a large knife, broad at the outer end and narrow near the handle; it is not much thicker than a saw-blade, and rings at every stroke. With these the canes are cut near the ground and the top removed; they are next stripped of the leaves by a dexterous movement and cast into heaps: these are gathered and thrown into the carts which convey them to the sugar mill. The machinery in the mills and the buildings connected with them involves the outlay of a large amount of capital: the works are driven by a steam-engine which moves the crushing rollers and the bands upon which the canes are carried to them: these moving bands extend out into the yard near the buildings, in which the canes brought from the fields are deposited. They run along the bottoms of two troughs, through one of which the canes are carried up to the crusher, and through another the crushed canes carried out in the opposite direction, and discharged in the yard, where they are spread out in the sun to dry. The juice (*guaropo*) running from the crushers is caught in a trough, and carried down to a series of large cauldrons, heated beneath by means of furnaces. The fuel principally used to heat these furnaces is the dry, crushed cane, which has been spread out in the yard around the buildings of the estate; but wood and other kinds of fuel are also used. As the cane-juice is concentrated by boiling in the kettles, it is frequently skimmed to remove impurities, and is clarified with lime. As it continues to thicken it is passed onward from one kettle to another, till, in the last, it reaches the granulating point, and is then pumped out into the cooling pans. In these large shallow vats the syrup is left for a while to cool and solidify into moist sugar. When sufficiently cool to be handled, a gang of negroes, shovel in hand, step into the pan and throw it out into little wooden box-cars, which carry it along a tramway to the purging house. Here it is put into casks, in which several sticks are set upright to aid the molasses in its passage to the bottom of the cask. These casks rest on poles, beneath which is a sloping floor on which the molasses runs down to gutters leading into a general receptacle or tank. On some estates there is a distillery attached to the purging house, and the molasses, skimmings of the kettles, &c., are converted into rum (*agua ardiente*). Where there is no distillery, the waste products of the sugar houses are conducted by a drain to some point at a distance from the buildings. In the neighborhood of the little black pond at the discharge of such a drain, an odor pervades the air, which may be appeciated by opening the hatch of a sugar-laden vessel on her arrival from a long sea-voyage. When the sugars are sufficiently drained, they are packed in casks and sent to the port of shipment: here the merchant takes charge of them and packs them afresh at his warehouse, in the casks in which they are sent to Europe and North America, and are delivered for consumption.

The molasses also is pumped from the vats in the purging houses on the estates into casks, and forwarded to the consignees at the port of shipment. The best modern appliances for improving the qualities of the sugars produced are not universally applied in the district of Cienfuegos. Vacuum-pans are to be seen on some estates, but the process of sugar making in general use is the more primitive one which I have described.

The prosperity which for many years has attended sugar cultivation in Cuba has greatly increased the population and wealth of the district of Cienfuegos, which is said to number more than thirty thousand inhabitants. Evidences of this may be seen, not only in the appearance of the thriving town where it centres, but in the trade carried on, on such an insignificant stream as the Damuji.

The Damuji, though of small size, is quite an attractive stream, and well worthy of a visit from any one who may be so near as Cienfuegos. I have already spoken of its aspect near the mouth, where the banks are bordered with mangrove swamps. This monotonous fringe disappears as one approaches the Ferry, and from this point onward, to the head of navigation, there is every variety of scenery which a somewhat flat, but rolling country, will admit of. A luxuriant growth of trees fringes the stream, except in places where the cane-fields of the estates, which line the banks, come down to the shore. Groves of elegant palm-trees, lordly ceibas, the silvery-leaved trumpet-tree, or the deep green glossy foliage of the Indian fig, appear at intervals along the slopes and swales descending to the stream. Elsewhere the banks of the river are covered with a dense forest, bristling with parasites, and matted with interlacing vines. The navigable part of the Damuji abounds in water fowls: at every bend of the stream we came in sight of flocks of cranes, herons and other aquatic birds, among which the white and scarlet ibis were conspicuous. Near the head of navigation, where the banks of the stream become somewhat rocky, and the grasses and undergrowth come down to the water's edge, a more timid water bird, the *gallinuela*, is common. Here the openings along the shore are less numerous, and the plantations further apart. It was along this river only that I saw anything like tropical luxuriance in the vegetation; the country, at the time of my visit, having been parched by many months of drought.

In sailing along the front of the bold mountain range at the eastern end of Cuba, the whole slope, from the summit almost to the water's edge, was clothed with what appeared in the distance to be a covering of little bushes, like the heaths of northern lands; but which, on a nearer approach, was resolved by a marine glass into a thick growth of trees, seemingly as devoid of leaves as any of our own hardwood trees in winter. During the dry season the greater part of the plants are taking their rest, and it is only in the case of the evergreen species, or of those growing along the sides of the streams, where perennial verdure reigns, that anything approaching the luxuriant display of foliage which we are accustomed to associate with scenes in the Indies can be seen. On the hills about the mouth of Xagua Bay, I had an opportunity of seeing something of the brown leafless upland forests, such as cover at this season the slopes of the Cuban mountains. A noticeable feature in these woods is their low stature, and the great abundance of trees of the family *Leguminosæ.* *Cacti* are frequently seen, both trailing and arborescent species; and, here and there, that remarkable plant the American Aloe (*Agave Americana.*) It becomes an object of beauty, conspicuous for miles, when, at the close of its life, it exhausts all its energies in producing that magnificent tree-like flower-stalk (20–30 feet high), gilded with thousands of bright yellow blossoms, which, when vitality has quite departed, remains for years a withered monument of its fecundity. Perhaps no feature in the vegetation of the West Indies strikes a visitor from the higher latitudes of America more forcibly than the varied forms assumed by the plants of the Pea-tribe. Accustomed as we are only to the herbaceous clovers, vetches and peas, or, where intercourse with the South is more free, to the introduced locust tree, one can scarcely realize, without actually seeing them, the many forms in which this family meets us. Not only does it supply the Cubans with timber, but also with dyes, resins, flowering shrubs, hedge-plants, medicinal herbs, &c.

Another very striking feature in the Cuban woods is the presence of epiphytes, or air-plants, in abundance: they are chiefly of two natural orders, the Orchids and the Bromelians. The former have flowers of peculiar aspect and much beauty, and the latter are supplied with seeds fitted to float on the breeze and find lodgment in the crevices and clefts of trees. They are the birds of the vegetable kingdom, live in the air, are nourished in the trees, and renew their life without visiting mother earth.

On some of the rough-bark trees these parasites cluster in countless numbers, and form a conspicuous part of their foliage. The Jucaro (*Bucida Buceras*), for instance, seems literally oppressed with the swarms of Tillandsias bristling on every bough; but such trees as the majestic Ceiba and the Royal Palm rear their smooth grey trunks far above the ordinary forest growth, seeming quite regardless of the small seeds that float by them. A few effect a lodgement among the lofty branches of the Ceiba, but the Cuban Palm utterly repels them from its smooth stony surface. Two plants of the family *Bromeliaceæ* are of great value to the Cuban husbandman, viz. the Rat-pine, used in hedging, and the well known Pine-apple. Creepers (*Ipomœa*) everywhere deck the hedges, and fill the air with their perfume. The Mallow family (*Malvaceæ*) and other allied groups, with mucilaginous foliage and flowers, are largely represented, and include the loftiest forms of forest growth, as well as plants notable for their economic worth. The immense order of composite plants, though only herbs with us, rise in Cuba to the dignity of shrubs, and present many curious forms. *Veroniaceæ* and *Eupatoriaceæ* prevail to a greater extent than in Eastern Canada; while the *Asteroideæ* are not nearly so abundant. Indeed I met no representatives whatever of the genera *Aster* and *Solidago*, of which so many forms and such countless numbers of individuals deck our fields and waste-lands in autumn. So also the thistle division (*Cynareæ*) of this order seems scarce or wanting. The order *Euphorbiaceæ*, insignificant herbs at the north, includes shrubs, as well as herbs, of great economical importance. In this group the Cubans find plants from which they obtain oil, medicine, farinaceous food and other products. Among the families of tropical plants known to us only by their fruits, may be mentioned the *Anonaceæ*, producing the Sweet-sop and Sour-sop; the Orange family (*Aurantiaceæ*), wherein are the Orange, Lime, Lemon and Shaddock; the Myrtle family (*Myrtaceæ*) which supplies to the Cuban his Guava and Pomgranate; other families giving him the Star-apple, the Avocado pear, and the curious melon-like Papaw. Two plants of the Chincona family, namely the Coffee Tree and Indian Mulberry, are not uncommon in waste places. Our beautiful but nauseous Lobelias are fitly personated by one species of terrible potency—if the anecdotes of the Creoles are to be relied upon—in the beautiful, but deadly *Isotoma*. The Bignonia family has trees which, when in bloom, are the glory of the Cuban forests and shrubberies, and, in fruit, bear arcuate pod-like seed vessels, sometimes of great length. The ornamental family to which the *Æanthus* belongs has several representatives in Cuba; and the allied group of Figwort (*Scrophulariaceæ*) is also present; but many of the genera in this large order, with which we are familiar, are wanting. Among the species of the useful and aromatic Mint family (*Labaiatæ*), but few northern genera are to be met with; but the allied family of *Verbenaceæ* is represented in the Lantanas. In the several species of *Heliotropium* we are reminded of the tropical affinities of our window-garden favourite, and note that, though colossal as compared with it, all have the circinate one sided racime of pale flowers, Another group, which, but for the interchanges of commerce, would be foreign to our shores, flourishes here as if at home; this is the potato family (*Solanaceæ*), species of which grow wild in all parts of the Island. Both the Pepper plant and the Tomato often arrest the attention by the display of their bright red fruit; the latter in its clusters of little cherry-like fruit, when compared with the large varieties grown in Canada, tells how much the plant has been modified by cultivation, in its progress northward. Two of our northern families with milky juice and pretty flowers are well represented in Cuba: they are the Dogbane (*Apocynaceæ*) and the Milk-weed (*Asclepiadaceæ*). A species of the latter is counted an efficacious medicine in fever. The maritime species of the Goosefoot family (*Chenopodiaceæ*), also have representatives on the Cuban shores, as the Globe Flowers and Amaranths have in the fields. As a counter part to the "Wait-a-bit" Thorn of Southern Africa, the *Una-de-gato* of the West Indies claims the attention of even the most careless traveller, by marking his face and his hands if he rides carelessly where it abounds. It has formidable recurved spines which will rend even the strongest leggings. Among the subdivisions of the Nettle family to be found in Cuba are the Indian Fig and the India-rubber tree. These, as well as the Mango, offer examples of dense and beautiful evergreen foliage at the driest season of the year, when the Ceibas, gummous trees and many others are almost stripped of leaves. Our well known family of Arums is scarcely to be recognized in the *Philodendron*, with its round, bright green stem, ascending the trunk of some lofty tree, and clinging to it by the roots which it emits from each joint of the stem in its upward progress. Nor would we easily recognize the Nettle family in the *Phoradendron*, which, in like manner, finds the forest trees a convenient resting-place, where it may display its little orange-colored blossoms. The Butter-cup family (*Ranunculaceæ*), representatives of which are met with on every hand in our own land, is scarcely to be recognized among the profusion of tropical forms in Cuba. The great family *Rosaceæ* as well as the Violet, Heath, Mustard, Pink and Parsley families, and many others which abound with us, are almost excluded from the West Indian Flora.

In the same category must be placed the four great arboreal groups which form the bulk of our forest growth; namely, the *Aceraceæ* (Maples), *Cupuliferæ* (Oaks, Butternuts, Beeches, &c.), *Amentaceæ* (Birches, Alders, Willows, Poplars, &c.), and the *Coniferæ* (Pines, Spruces, Firs, Larch, &c.) The last do not seem to have found a foot-hold even on the mountain tops, which, as already observed, exhibit in the dry season a uniform growth of trees, which, judging from their brown color, are quite divested of leaves, and have nothing in common with our evergreen forests.

As is the case with a number of orders already mentioned, so also the tropical grasses include some large and even gigantic forms; as for example *Plyra* and *Bambusa*. In the ferns, too, among the flowerless plants, there is the Golden Fork-fern (*Acrostichum*), growing to a height of nine or ten feet. The genus *Adiantum* (Maiden-hair), also includes some beautiful species with delicate leaves and hair-like stemlets.

But the greatest charm of a southern landscape, and that which marks it distinctively from views in northern lands, is the presence of the Palms (*Palmaceæ*). Nothing can be more attractive to the eye than the airy elegance of the Royal Palm, whether it be a few solitary individuals whose star-like clusters of green fronds stand out against the deep blue tropical sky, or the groves one meets with in rich swales and sheltered hollows. In these groves may be seen long vistas of straight round columns, very smooth, almost as hard as stone, and nearly as white as marble, loosing their tall shafts in a dense, feathery, waving canopy of foliage, high over head.

Possibly it was from such an ideal as these groves offered to his fancy, that the Greek drew his conceptions of architectural beauty; even as the Goth in later ages embodied the recollections of sylvan majesty which the sombre woods of Northern Europe, with their great rude trunks and lofty over-arching branches, left upon his memory, in the grand ecclesiastical buildings of mediæval times.

NOTES ON A DEEP-SEA DREDGING EXPEDITION ROUND THE ISLAND OF ANTICOSTI, IN THE GULF OF ST. LAWRENCE.

By J. F. Whiteaves, F.G.S.

The following article is to a large extent a reproduction of one contributed to the "Annals of Natural History" for November, 1872. The results of nearly a year's additional study of the specimens collected are, however, incorporated into the present sketch.

No dredging operations have ever been conducted in the deepest parts of the River and Gulf of St. Lawrence, so far as I can learn, until the summer of 1871. In 1867 and 1869 I dredged in upwards of fifty different localities north of the Bay of Chaleurs, but never in deeper water than 50 fathoms. The researches of Dr. Packard and others on the coast of Labrador, those of Principal Dawson, Prof. Bell, &c. in the Gaspé district, together with those of Mr. Willis in the seas of Nova Scotia, were all carried on in comparatively shallow water. On several occasions I have called the attention of the Natural History Society of Montreal to the importance, from a scientific point of view, of a careful investigation into the nature of the animal and vegetable life of the greater depths of the Gulf, which seemed to me to promise a rich harvest of new facts.

A committee was appointed to petition the Dominion Government to allow qualified observers facilities for deep-sea dredging on board government vessels. Principal Dawson also, as President of the Society, represented to the Honourable the Minister of Marine and Fisheries the practical value of, and the useful results that might accrue from, such inquiries, and met with the most liberal response. The desired facilities on board government cruisers were at once promised, the necessary rope was provided, and no efforts were spared to make the cruises successful. I was deputed by the Natural-History Society to undertake the management of the expedition, and left Montreal early in July, 1871. My friend Mr. G. T. Kennedy, M.A., of Montreal, a skilfull zoologist, started with me, but returned after he had been a few days at sea.

The first cruise was on board the government schooner 'La Canadienne,' and lasted three weeks. The ground examined on this vessel was from Point des Monts (on the north shore of the St. Lawrence) to the Mingan Islands, then round the west point of Anticosti, and from there, in a diagonal line, to Gaspé Bay. Next, embarking on board the 'Stella Maris' at Gaspé Basin, we made an entire circuit of the island of Anticosti, sailing as far to the north-west as Sawhill Point, on the north shore, and to the south-east as the Magdalen Islands. We were driven to Byron Island, one of the Magdalen group, by a "nor'-wester," which of course prevented our dredging there. As these investigations were entirely subordinate to the special duties upon which the two schooners were engaged, dredging could only be carried on at intervals, and in several cases the same ground was gone over twice or more.

On 'La Canadienne' we had sixteen successful hauls of the dredge. Of these, four were in 50 fathoms of water or less, seven in between 50 and 100 fathoms, and five in from 100 to 200 fathoms.

On the 'Stella Maris' we had nine successful hauls. One of these was in less than 50 fathoms, two were between 50 and 100, and six between 100 and 250 fathoms.

The deep-sea mud, in the places examined, is dotted over with more or less water-worn masses of rock, usually of Laurentian gneiss, varying in size from that of a pea to considerably larger than a man's head. By a modification of the usual sieving process, every organism, piece of rock, &c., larger than one-sixteenth of an inch in diameter was first picked out from the mud. A large bagful of the residue, from each locality examined, was preserved for subsequent microscopic examination. Three fourths of this mud was found to be a silt so impalpable as, when wet, to pass readily through fine cambric; the remaining fourth consisted half of organic, and half of inorganic matter. The organic matter comprised a few diatoms, multitudes of Foraminifera, some Polycystina, many sponge spicules, and fragments of other organisms. The inorganic débris was a more or less coarse kind of sand, made up of fragments of quartz, bits of felspathic rock, and small flakes of mica.

Attempts were made to endeavour to ascertain the approximate temperature of the deep-sea mud. When the dredge was hauled up, its contents were emptied as quickly as possible into a large shallow tub; and this was covered with a tarpaulin and placed in the shade. An ordinary thermometer, with a metal case and perforated base, was then plunged into the mud, and the whole was kept carefully shaded for a time. With one exception, the temperature of the mud was found to be from 37° to 38° Fahr., and this not alone in deep water; for sand brought up from 25 fathoms, on the north shore of the St. Lawrence, also made the mercury sink to 38° or 37° Fahr. In the centre of the river, between the island of Anticosti and the south shore of the St. Lawrence, mud brought up from 200 fathoms, only made the mercury sink to from 43° to 45° Fahr. Either a warm current affects the temperature of the bottom at this point, or else my observations were inaccurate or defective, which latter assumption is by no means unlikely.

With a view of trying to get some information as to the nature of the food of some of the surface-feeding fishes, and especially of the herring and mackerel, towing nets were frequently used; but comparatively few specimens were taken in these. Hempen tangles, similar to those devised by Captain Calver, were also employed, and with much more success.

The following is a brief sketch of some of the most interesting forms of animal life obtained during the expedition. During the autumn of 1871, Mr. J. Gwyn Jeffreys, F.R.S., visited Montreal, and went over the whole of the testaceous Mollusca with me. I am also indebted to Professors A. Agassiz, A. E. Verrill, and S. I. Smith for the identification of several critical species.

FORAMINIFERA.

Large quantities of these beautiful organisms were collected, especially from very deep water, but at present only a portion of these have been carefully examined. In Mr. G. M. Dawson's paper on the "Foraminifera of the River and Gulf of the St. Lawrence," published in Vol. 5 (New Series) of this Journal, a list is given of fifty-six subspecies or varietal forms. Among the individuals collected last year in deep water are a number of large specimens to which it is difficult to attach any name, but which form a series connecting the subgenera *Nodosaria*, *Dentalina*, *Marginulina* and *Cristellaria*. One of the most remarkable of these is a Marginulina with long spinous processes developed from the first chamber. It is probably *M. spinosa* of M. Sars. *Cristellaria crepidula* and *Trochammina incerta* were collected in comparatively shallow water (30 to 40 fathoms) ; and *Bolivina punctata*, *Nonionina umbilicatula*, *Valvulina austriaca*, and gigantic examples of a *Triloculina* allied to *T. tricarinata*, (perhaps *T. cryptella*, D'Or,) reminding one of miniature beech-nut seed carved in ivory, were dredged in from 200 to 250 fathoms. By far the greater number of the St. Lawrence Foraminifera seem to have a wide range in depth. I have examined large bagfuls of dredgings from more than fifty localities in the northern part of the Gulf, and out of fifty or sixty species or varietal forms, only four or five seem peculiar to deep water. *Virgulina squamosa*, *Bolivina costata* and *squamosa*, *Nonionina umbilicatula*, and the *Triloculina* previously mentioned are apparently only met with in from 200 to 300 fathoms water. In the St. Lawrence, *Lagena distoma* (typical), *Bulimina pyrula* and *marginata*, and *Valvulina austriaca* are characteristic of deep water, but are very rarely met with in lesser depths. *Globigerina bulloides*, though small, is not unfrequent at all depths ; but, curiously enough, *Orbulina universa* has not yet been found living in Canada. Although many of the Foraminifera from the deep water are small and delicate, by far the largest specimens yet collected were taken in from 200 to 250 fathoms. This agrees with the result of Dr. Carpenter's observations on board the 'Porcupine.' The *Rhabdopleura* figured by Mr. Dawson I believe to be an annelid tube, having examined the animal in a living state.

POLYCYSTINA.

Dictyocha aculeata and a species of *Ceratospyris* have been previously catalogued from the Gulf of St. Lawrence by Principal Dawson. Three additional species were dredged in upwards of 200 fathoms; but these are at present undetermined. In Canada, Polycystina are not peculiar to deep water; for I have taken fine specimens from the interior of a species of *Halichondria*, also from the stomach of *Echinus dröbachiensis*, both collected from a little below low-water mark.

SPONGES.

Several examples of the *Grantia ciliata* of O. Fabricius were dredged from 96 fathoms in Trinity Bay, on the north shore of the St. Lawrenee. It is the first sponge with calcareous spicules recorded from the Gulf. The straight spicules of the terminating cone and the triradiate ones of the body of the sponge, make beautiful polariscope objects. Another species, which I at first thought referable to Bowerbanks genus *Polymastia*, occurred frequently in deep water. Since my paper in the 'Annals' was written, the inspection of a copy of Dr. Wyville Thompson's new volume "The Depths of the Sea," and the receipt by the Society of Prof. H. A. Pagenstecher's paper entitled 'Zur kenntniss der Schwämme,' have enabled me to rectify this error. The sponge in question is evidently *Thecophora semisuberites* of Dr. O. Schmidt. The diagnosis of the genus cited by Prof. Pagenstecher agrees well with St. Lawrence specimens. The character "Rinde aus homogen verdichteter Sarkode" (outer skin of a thickened and homogeneous sarcode) is a very conspicuous feature in the Canadian sponge, the spicules of which are uniformly spinulate fusiform. A massive *Halichondria*, allied to *panicea*, but differing from it in some respects, was taken in 38 fathoms off Cape Rosier village. The larger spicules are like those of *H. panicea*, but it has, in addition to these, numerous small retentive bihamate ones. The remainder of the deep-sea sponges have yet to be identified.

Hydrozoa.

The Hydroid polyps collected were tolerably numerous. The following species have been recognized, but only a portion of the series has been carefully examined.

(Athecata.)

Coryne pusilla, Gaertner.
Tubularia indivisa, Linn.

(Thecaphora.)

Campanularia verticillata, Linn.
Lafoea dumosa, Fl.
" *fruticosa*, Sars.
Salacia abietina, Sars.
Sertularella rugosa, Linn.
" *tricuspidata*, Alder.
Sertularia pumila, Linn.
" *filicula*, Ellis & Sol.
" *abietina*, Linn.
" *argentea*, Ellis & Sol.
Hydrallmania falcata, Linn.
Thuiaria thuja, Linn.
" *articulata*, Pallas.

Actinozoa.

In the lowest order of this class, the Alcyonaria, the most interesting discovery was that of a fine series of Pennatulœ. About 50 or 60 living specimens were taken in the centre of the river between Anticosti and the south shore of the St. Lawrence, in depths ranging from 160 to 200 fathoms. In the largest specimens collected there are 40 pinnules on each side of the upper portion of the cœnosarc; but in average full-grown examples the number is less, and ranges from 30 to 35. On the back of the rachis there is a central groove, on each side of which are numerous but unequal, spinose, undeveloped polyps. The average number of polyp-bearing cells on each pinnule seems to be about 11, but varies from 9 to 16. The polyp-bearing cells are entirely separate, and are margined with bundles of spines. The 8 mesenteries and somatic chambers, as well as the 8 tentacles of the polyps, can be well made out in the specimens collected. In one specimen examined by Mr. G. T. Kennedy the basal portion of the pinnules is filled with spheres of granular matter. The spicules of the lower half of the stem are elliptical or oblong, and dicidedly constricted in the middle. The calcareous internal axis is somewhat longer than the cœnosarc itself, and is recurved at the base. Large examples measure about 8 inches; but some are only 6 inches long, or even less. These latter specimens have as few as 21 pinnules on each side of the stem.

My first impression, on examination of the Canadian Sea Pen, was that it differed materially from any described species, and that view was also taken by Prof. Verrill. But under the name *Pennatula phosphorea* Kolliker includes so many varieties and sub-varieties, and my specimens differ so much among themselves, that they may possibly rank as forms of that protean species. If P. *aculeata* of Daniellssen be included among the synonyms of P. *phosphorea*, so I think must my P. *Canadensis*. But if, as Prof. Verrill claims, P *aculeata* is distinct from P. *phosphorea*, then the Sea Pen of the St. Lawrence must be called *Pennatula aculeata, var. Canadensis*. The species collected of the limited genus Alcyonium are three in number. One is probably A. *rubiforme*, Ehr., another comes near A. *carneum*, Ag., and there is a third species, found exclusively in very deep water, which has yet to be determined. This last, however, Prof. Verrill informs me, is not *Eunepthya glomerata*, as he at one time supposed. Besides these three there is another creeping Alcyonoid from deep water, apparently belonging to a genus near to Cornularia. Two species of Sea Anemone were dredged, attached to stones, in from 100 to 200 fathoms. One is *Urticina crassicornis*, and the other *Urticina digitata* of Muller. A creeping compound anemone, closely allied to *Zoanthus*, taken on stones at a depth of 212 fathoms, appear to be *Epizoanthus Americanus*.

ECHINODERMATA.

In the deep sea mud, at depths of from 100 to 250 fathoms, the following species occurred more or less abundantly.

Schizaster fragilis. (*Brissus fragilis*, Duben and Koren).
Ctenodiscus crispatus, Duben and Koren.
Amphiura, near to A. *borealis*, Sars.
Ophiacantha spinulosa, Mull.
Ophioglypha Sarsii, Lutken, (large.)

In 69 fathoms, off Sawhill point, a curious Asterid was dredged, which is probably the *Korethraster hispidus* of Wyville Thompson. A few specimens of *Astrophyton Agassizii* were collected from 60 fathoms mud, off Thunder River; and *Asterias Greenlandicus*, Steenstrup, was occasionally met with at depths of from 30 to 60 fathoms.

Annelida.

The whole of the deep sea worms collected have been sent to Dr. W. C. McIntosh, F.L.S., (of Murthly, near Perth, Scotland) to whom I am indebted for the identification of the 12 species, of which a list is given below. In the deep sea mud, between 100 and 250 fathoms, the annelids determined so far, are as follows:

Ammotrypane aulogaster, Rathke.
Amphictene auricoma, Mull.
Amphiporus, sp.
Ephesia gracilis, Rathke.
Eunoa nodosa, Sars.
Goniada maculata, Œrsted.
Lineus, sp.
Lumbrinereis fragilis, Mull.
Nothria conchylega, Sars.
Praxilla gracilis, Sars.
Sabella pavonia, Savigny.
Terebellides Stroemii, Sars.
Thelepus circinatus, Fabr.
Trophonia plumosa, Mull.

In addition to these, Dr. McIntosh informs me, "there is a specimen of a small Balanoglossus, while a Lepidonotus, Nepthys, Maldane, Praxilla and Nothria, need determination." Of the 12 species at present identified, 11 are also found in the seas of the Shetlands.

Crustacea.

Although the Crustaceans collected are not very numerous in species, some of them are of considerable interest. The following is a list of those determined at present:

(Decapoda.)

Cancer irroratus, Say. Low water mark, Ellis Bay, Anticosti, and elsewhere.

Chionocœtes opilio, Fabr. Specimens of large size are not unfrequently met with, thrown ashore.

Hyas coarctata, Leach. Low water mark down to 60 or 70 fathoms.

Hyas aranea, Linn. With the preceding.

Eupagurus Kroyeri, Stimps.

Eupagurus pubescens, Stimps. Both common in shallow water.

Sabinœa septemcarinata, Sabine. Occasional.

Hippolyte Phippsii, Kroyer. 90 to 100 fathoms, scarce.

Hippolyte Fabricii, Kroyer. 125 fathoms, off Cape Rosier.

Hippolyte polaris, Kroyer. 38 fathoms, off Cape Rosier.

Hippolyte spina, White. 38 fathoms off Cape Rosier.

Pandalus annulicornis, Leach. Frequent at all depths.

(Amphipoda.)

Epimeria coniger? Fabr. Of large size in deep water.

Eusirus cuspidatus, Kroyer. Two examples.

(Isopoda.)

Munnopsis typica, M. Sars. 125 fathoms, off Cape Rosier lighthouse.

(Pycnogonoidea.)

Pycnogonum littorale, Ström. (=P. pelagicum, Stimpson.) Brought up by hempen tangles from 212 fathoms mud, between the East Point of Anticosti and the Bird Rocks.

Nymphon giganteum, Goodsir. 125 fathoms, off Cape Rosier lighthouse.

Polyzoa.

Good specimens of the following species have been determined, from depths of from 90 to 250 fathoms; but many interesting forms are at present unnamed:—

Crisia eburnea, Linn.
Idmonea atlantica, Forbes.
Defrancia lucernaria?, Sars.
Alcyonidium gelatinosum, Pallas.
Scrupocellaria scruposa, Linn.
Cellularia ternata, Ell. & Sol.
Gemellaria loricata, Linn.
Caberea Ellisii, Flem.
Bicellaria ciliata. Linn.
Acamarchis plumosa, Pallas.
Flustra Barleei, Busk.
Retepora cellulosa, *var. elongata*, Smitt.

Tunicata.

The following is a list of the few species of this order at present identified by Prof. A. E. Verrill:—

Ascidiopsis complanatus (=*Ascidia complanata*, Fabr.) In 212 fathoms to the south-east of the east point of Anticosti.

Eugyra pilularis, Verrill. In 50 fathoms off the St. John's River, Mingan.

Botryllus, a purple species, distinct from *B. Gouldii*, Verrill. Attached to *Flustra Barleei?*, Busk, from 96 fathoms in Trinity Bay.

Several examples of *Amourœcium glabrum*, Verrill, were collected in and just outside of Gaspé Bay, where I had previously dredged it in 1869.

MOLLUSCA.

In the 'Canadian Naturalist' for 1869, I published a catalogue of 114 species of marine Mollusca inhabiting the Gulf of St. Lawrence, to the north of the Bay of Chaleurs. We now know localities for 150 species which inhabit the region in question. The shells collected last summer have been carefully studied; and the following is a list of some of the most interesting among them*.

Terebratula septentrionalis, Couth. In 112 fathoms, stones, off Charleton Point, Anticosti, and in 212 fathoms to the S.S.E. of the east end of that island.

Terebratella Spitzbergensis, Davidson. 38 fathoms, stones, off Cap-Rosier lighthouse, alive, adult, and frequent; 96 fathoms, in Trinity Bay, one young, but living example; 112 fathoms, off Charleton Point, Anticosti, one dead, adult. Most abundant in somewhat shallow water.

Pecten Grœnlandicus, Chemn. Take alive in several localities in from 160 to 250 fathoms, mud.

Lima sulculus, Leach. Fine specimens in 38 fathoms, off Cap-Rosier lighthouse.

Arca pectunculoides, Scacchi (= *A. raridentata*, Searles Wood.) Dredged on the north shore of the St. Lawrence, also between Anticosti and the south shore, in 160 to 170 fathoms. The specimens were often living, and of large size for the species. New to the western side of the Atlantic.

Arca glacialis, Gray (==*A. raridentata*, var. *major*, Sars). A few dead examples of this shell were taken with the preceding one.

Yoldia (? *Portlandia*) *thraciæformis*, Storer. One living specimen occurred in 212 fathoms, S.S.E. of the east point of Anticosti, and a dead, but perfect one, in 125 fathoms, off Cap Rosier.

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* I am indebted to Mr. J. Gwyn Jeffreys, F.R.S., for the determination of those species to which an asterisk is affixed.

Yoldia (*Portlandia*) *lucida*, Lovén. Living in seven of the localities examined, its range in depth being apparently from 150 to 250 fathoms.

**Yoldia* (*Portlandia*) *frigida* Torell. Frequent, living with the preceding. This and the preceding are new to America.

Dacrydium vitreum, Möll. In 212 fathoms, mud, to the S.S.E. of the east point of Anticosti, living.

Cryptodon Gouldii, Philippi. Common, living, at all depths; it ranges from 10 to 250 fathoms.

Astarte lactea, Brod & Sow. Fine in several localities. Off Sawhill Point in 30 fathoms; off Moisie village in 70 fathoms; mouth of St. John's River, Mingan, in 50 fathoms; Gaspé Bay. The young is *Astarte Richardsonii*, Reeve.

ASTARTE. Two species of *Astarte*, both of the *A. sulcata* group, were collected in deep water. One, of which two specimens only were dredged (off Bear Point, Anticosti, in 112 fathoms), I at first thought to be *A. crebricostata;* the other is by far the most abundant mollusk of the greater depths of the northern part of the river and gulf of the St. Lawrence. Mr. Jeffreys says that this latter shell is *Astarte sulcata*, var. *minor*. No specimens that I have seen, from American or European localities, exactly resemble either of these shells; and in my judgement, both are new and good species.

Tellina (*Macoma*) *inflata*, Stimpson, MSS. Perhaps *M. fragilis* of Leach. Fine living specimens of a shell which the late lamented Dr. Stimpson gave to the writer some years ago, with the label "*Macoma inflata*, St. MSS.," were dredged in 70 fathoms, sand, off Moisie village, and at various depths in other localities.

**Neæra arctica*, Sars. Several living specimens of this species (the largest of which measures upwards of an inch and a quarter in its greatest breadth) were taken in 125 fathoms, off Cap-Rosier lighthouse; also in 200 fathoms, mud, Ellis Bay, Anticosti, bearing S.S.W., 27 miles distant.

Neæra obesa, Lovén (=*N. pellucida*, Stimpson). Off Caribou Island, on the north shore of the St. Lawrence, nearly opposite Cape Chatte, living, in 170 fathoms, mud. I regard both *N. arctica* and *N. obesa* as varieties of the European *N. cuspidata*, *N. arctica* being adults of unusual size, and *N. obesa* the young of the same species. In deference to Mr. Jeffreys's greater experience, however, I keep the two forms separate. *N. arctica* has not previously been found on the American coast.

Utriculus pertenuis, Mighels. In 25 fathoms, sand off Trinity River, also in Gaspé Bay; abundant at both localities. (Probably =*U. turritus*, Möller.)

**Utriculus hyalinus?*, Turton (=*Diaphana debilis*, Gould). With the preceding, but rare in both places.

**Philine quadrata*, Wood. Alive, from 212 fathoms, mud, to the S.S.W. of the east point of Anticosti.

Philine lineolata, Couth. Gaspé Bay, and off the St. John's River, Mingan, in 50 fathoms.

Dentalium abyssorum, Sars. Dead but good specimens of this species were dredged in three localities:—in 184 fathoms, mud, off Seven Island Bay; also in 150 and 200 fathoms to the S.W. and S.S.W. of Ellis Bay, Anticosti. New to America.

Siphonodentalium vitreum, Sars. Deep water, in several localities, fine and living. Most frequent in 200 to 250 fathoms; also new to the American side of the Atlantic.

Margarita argentata, Gould (=*M. glauca*, Möll.) Off the mouth of the St. John's River, Mingan, in 50 fathoms, and sparingly in other localities. Gaspé Bay.

Margarita striata?, Brod. & Sow. A remarkable variety of this species, with three unusually prominent revolving ribs (so much so as to remind one of some of the Australian Trochocochleas), occured in 70 fathoms, sand, off Moisie village. The type is abundant and large everywhere in the St. Lawrence in shallow water.

Rissoa carinata, Mighels. Frequent, alive, from 96 fathoms in Trinity Bay.

Rissoa castanea, Möll. With the above and elsewhere not unfrequent.

Rissoa scrobiculata, Möll. Collected in three localities, in from 125 to 250 fathoms, where it is large and fine. It occurs living, but of small size, in Gaspé Bay, at depths of from 20 to 30 fathoms.

Rissoella eburnea, Stimpson. One living and adult example, in 70 fathoms, off Mosie village.

Lacuna glacialis, Möller. A living adult specimen of this species was dredged from 96 fathoms in Trinity Bay.

Aporrhais occidentalis, Beck. A remarkable thin and inflated variety of this species was taken in 120 fathoms off Bear Head, Anticosti. The type is not uncommon throughout the Gulf, in from 20 to 50 fathoms.

Eulima stenostoma, Jeffreys. A single living adult was taken from 160 fathoms, to the south-west of Ellis Bay, Anticosti. New to America.

Astyris Holböllii, Möll. (= *Columbella rosacea*, Gld.). Trinity Bay, 96 fathoms, also other localities. Ranges from 20 to 100 fathoms.

Buccinum ciliatum, O. Fabr. Alive, in 112 fathoms off Charleton Point, Anticosti.

Buccinum cyaneum?, Brug. From 250 fathoms, mud, between the east point of Anticosti and the Bird-rocks.

Sipho islandicus, Chemn. Only one living example of this mollusk was collected, from 112 fathoms, off Charleton Point, Anticosti.

Sipho Sarsii, Jeffreys. With the above but much more frequent; also off Egg Island, in 70 to 80 fathoms. The epidermis is very different in these two species; but it is difficult to separate them when the specimens are water worn.

Trophon craticulatus, O. Fabr. Off Cap-Rosier lighthouse, in 38 fathoms, stones, fine and living; also near the mouth of the St. John's River, Mingan, and in 50 fathoms, sand, but dead.

Fasciolaria ligata, Mighels. Two living examples were taken in Gaspé Bay, near Cape Gaspé, on a stony bottom, in 20 or 30 fathoms.

Twenty-five species of shells not previously known to inhabit the seas of the Province of Quebec were collected during the two cruises; of these, twelve are new to the American side of the Atlantic.

FISHES.

The only fishes brought up in the dredge were a young specimen of each of the following species:—

Sebastes Norvegicus. The Norway haddock. 96 fathoms, Trinity Bay.

Anarrhichas lupus. The wolf fish. 112 fathoms, off Charleton Point, Anticosti.

Agonus decagonus?, Schneid. With the preceding.

It is estimated that, when the whole of the material collected has been examined with care and all the specimens are determined, upwards of 100 species of marine invertebrates new to the Gulf of the St. Lawrence can be added to its previously recorded fauna. Of these, from 30 to 40 species are new to the western side of the

Atlantic, and a few are undescribed. When it is considered that only five weeks were spent at sea, that during that time the ordinary duties upon which the schooners were engaged (and some times unfavourable weather) often made dredging quite impracticable, also that I was alone (so far as scientific help was concerned) nearly the whole time, I may be pardoned for thinking that the results of these investigations, so far as they go, are very encouraging and such as should stimulate to renewed exertions in so promising a field of inquiry.

I have previously shown (in the 'Canadian Naturalist' for 1869) that a large proportion of the Greenland invertebrates, probably three fourths of the whole, range as far south as the northern part of the Gulf of St. Lawrence down to Gaspé Bay. In Canada many marine animals (such as, for example, the oyster and the two species of *Crepidula* which are found attached to it) occur a little to the south of the Bay of Chaleurs, but not in the Bay itself. A number of characteristic New-England species inhabit the coasts of Nova Scotia and New Brunswick, most of which do not apparently range further north than the Bay of Chaleurs.

On the Admiralty Charts of the Gulf of St. Lawrence, an irregular line of 60 fathoms soundings may be seen to extend from a little above the northern extremity of the Island of Cape Breton, round the Magdalen group, and thence, in a westerly direction, to Bonaventure Island. To the south and south-west of this line the water is uniformly somewhat shallow, while to the north, north-west, and north-east the water deepens rapidly, and in some places precipitously. Principal Dawson suggests that the Subcarboniferous rocks of which the Magdalen Islands are composed, and which appear again on the mainland, in Bonaventure County, may possibly crop up under the sea in the area between the north-west side of Cape Breton and the mainland of New Brunswick, as well as that of the counties of Bonaventure and Gaspé, in the Province of Quebec. This may account, for the shallowness of the water in the area in question. Whether this is the case or not, it seems not improbable that the submarine plateau inside of this line of shallow soundings, may form a natural barrier to those arctic currents which sweep down the Straits of Belle Isle in a south westerly direction, and may tend to deflect their course in a bold curve into and up the river St. Lawrence.

In the centre of this river, opposite Murray Bay, about 80 miles below Quebec, Principal Dawson has dredged quite a large series of Labrador marine invertebrates; but how much further up the stream these salt-water denizens extend, we have yet to learn.

North of the Bay of Chaleurs the fauna of the Gulf of St. Lawrence has a purely arctic character. The species of which it is composed are remarkable alike for their geological antiquity and for their wide range of geographical distribution. In time, a few of them date back to as ancient periods as the Coralline and Red Crags, and a much larger number occur in the Post-pliocene deposits of both Europe and North America. It is curious to observe that species which are found both living on the American coast to-day and fossil in the European Pliocene and Postpliocene, had a different geographical range in former times from that which they are known to have now. Many of these arctic marine invertebrates are circumpolar in their distribution and not only inhabit both sides of the Atlantic, but are also found in the Northern Pacific. The preceding generalizations refer almost exclusively to the assemblage of marine animals characteristic of comparatively shallow water, the members of which range in depth from low-water mark up to about 50 fathoms.

The deep-water fauna, at least that of the localities examined, is also decidedly arctic, but it has at the same time a much more Scandinavian aspect. Nearly all of the species which are now for the first time recorded as inhabitants of the Atlantic coast of America occur also in the seas of the north of Scotland, of Norway, and Spitzbergen. There is a striking similarity between the series of fossils from the Quaternary deposits of Norway (as catalogued by Sars) and the marine invertebrates of the deepest parts of the St. Lawrence. *Pennatulæ*, *Ctenodiscus*, *Tripylus* (*Schizaster*) *fragilis*, *Ophioglypha Sarsii*, together with many species of mollusks, are common to both. Still it must be borne in mind that in the Quaternary deposits of Norway a number of characteristic European invertebrates occur, which, so far as we know, do not live on the western side of the Atlantic.

In the River and Gulf of St. Lawrence, generally speaking, the number of species of marine animals which may be collected at or above low-water mark is very small; few specimens, apparently, are washed ashore by storms. But there is a constant tendency in the opposite direction; littoral and shallow-water forms are constantly being drifted down to lower levels, particularly shells (which are usually dead and empty) and the larger calcareous Polyzoa, such as *Celleporaria incrassata* and *Myriozoum subgracile.* Sometimes the Mollusca are living: on one occasion I dredged an example of *Littorina rudis*, apparently alive, but certainly with the operculum fitting tightly into the aperture, from upwards of 100 fathoms water. When such is the case, it is often difficult to separate the true denizens of the deep sea from those which are washed down from shallower water.

Since the above was written, I have re-examined the Canadian Thecaphoræ, and find among them two examples of what seem to be *T. ibla* of Wyville Thompson. It is the spicules of what I take to be this latter species that are spinulate fusiform; those of *T. semisuberites* have yet to be studied.

NATURAL HISTORY SOCIETY.

PROCEEDINGS FOR THE SESSION 1872–73.

ANNUAL MEETING.

The Annual Meeting was held on May 18th, 1872, the President, Principal Dawson, in the chair.

After the minutes of the last annual meeting were read, the President delivered the Annual Address. This will be found on pages 1 to 15 of the present volume.

The Report of the Chairman of Council was next read by Mr. G. L. Marler, of which the following is an abstract. The number of new members elected during the past session is eight, while nineteen names have, from various causes, been taken off the list. This decrease was attributed partly to the inaction of the membership committee and partly to the circumstance that the operations of the Society are not as widely known as could be wished. A suggestion was offered as to the desirability of amalgamation with kindred societies, such as the Mercantile Library and the Fraser Institutes, and the advantages of such a plan were pointed out. The Annual Conversazione and the Field Day held during the past session have each resulted in some pecuniary loss, but it was thought that such meetings have a beneficial tendency, and that they should be continued. About 500 persons have visited the museum during the year, but as there was no officer residing on the premises during the first three months, an accurate record was not kept. One thousand dollars of the mortgage on the Society's buildings have been paid off, but there are still one thousand dollars due, and it was recommended that immediate exertions be made to raise this sum in order to free the Society from debt. During the current year an unusual outlay (of $337) has been necessitated for repairs, painting and cleaning.

The Report concluded with an expression of thanks to the other office holders.

The Reports of the Scientific Curator, Recording Secretary and of the Editing Committee of the 'Canadian Naturalist' were then read by Mr. J. F. Whiteaves, of which a brief and condensed account is submitted.

A deep sea dredging expedition to the Gulf of St. Lawrence, under the auspices of the Hon. the Minister of Marine and Fisheries was successfully carried out on behalf of the Society. More than 100 species of marine animals, new to Canada, were collected. These have been for the most part studied, identified and labelled, and a report on the general results of the expedition has been prepared for and published by the Department of Marine and Fisheries. Eight new specimens of Canadian birds have been added during the year. Fourteen species of birds and twenty-four of mollusca, collected by Mr. Richardson in British Columbia, have been presented by Mr. A. R. C. Selwyn. These have been mounted, labelled and incorporated into the general collection. Sir J. Duncan Gibb has kindly forwarded a large collection of British and exotic fossils. Mr. Peter Redpath has contributed a series of W. Indian sponges and alcyonoids. No cases being available to exhibit these, they have been carefully stored away, until a proper provision can be made for them. About three hundred species of recent shells have been mounted on tablets and labelled, and about 1000 more have been roughly grouped in drawers preparatory to mounting. The want of additional cases for the museum was strongly urged, especially of one for the preservation and exhibition of alcoholic preparations. The publishers of the 'Naturalist' having decided that the first No. of Vol. 6 should bear date, September 1871, three numbers have been issued, and it was hoped that the fourth would be ready in July. As soon as the volume is finished new arrangements will be entered into between the publishers and the Society.

The Treasurer, Mr. James Ferrier, jr., then submitted a statement of the financial position of the Society, of which the following is an abstract:

Dr. THE NATURAL HISTORY SOCIETY *in Account with* JAMES FERRIER, Jr., *Treasurer.* Cr.

1871-72.	
To Cash paid J. F. Whiteaves, salary	$400.00
" " S. W. Passmore, "	200.00
" " Pell, commission	29 35
" " Interest	100.00
" " for Coal	159.20
" " " Gas	25.92
" " " Water	34.70
" " " City Taxes	49.50
" " " Insurance	39.00
" " Repairs, and petty expenses	350.99
" " Books, printing and advertising	173.95
" " Loss on Field Day	5.25
" " Dredging expenses	94.28
" " Royal Institution	1000.00
	$2662.14

1871-72.	
By Cash rec'd. Government Grant	$750.00
" Balance in Treasurer's hands May 1, 1871	917.33
" Cash, Members' Yearly Subscriptions	435.00
" " Life " (D. A. P. Watt)	50 00
" " Subscriptions to 'Naturalist,'	164.00
" " Museum Entrance Fees	63.46
" " Rent of Lecture Room	227.00
" " Interest from Treasurer	21.78
" Balance due the Treasurer	33.57
	$2662.14

LIABILITIES.

Royal Institution, Balance on Mortgage	$1000.00
Dawson Bros. acc't	653.92
	$1653.92

Errors and omissions excepted.

(Signed) JAMES FERRIER, Jr.

Montreal, May 14th, 1872.

The various reports were adopted and ordered to be printed in this Journal.

On motion of Rev. Dr. De Sola, seconded by Mr. J. H. Joseph, a vote of thanks to the President for the address, and for his continued and valuable services to the Society, was passed unanimously.

The following gentlemen were then duly elected officers for the Session 1872–73:

President.—G. Barnston.

Vice-Presidents.—Principal Dawson, E. Billings, Dr. Smallwood, Rev. Dr. De Sola, A. R. C. Selwyn, His Lordship the Metropolitan, Dr. T. Sterry Hunt, Sir W. E. Logan, and Dr. P. P. Carpenter.

Treasurer.—Mr. J. Ferrier, jun.

Cor. Secretary.—Prof. P. J. Darey.

Scientific Curator and Rec. Secretary.—Mr. J. F. Whiteaves.

Council.—G. L. Marler, D. R. McCord, Prof. R. Bell, D. A. P. Watt, J. H. Joseph, E. E. Shelton, Dr. J. Baker Edwards, A. T. Drummond, and C. Robb.

Library and Membership Committee.—A. T. Drummond, Dr. John Bell, D. R. McCord, N. Mercer and Dr. B. J. Harrington.

FIELD DAY.

A field day was held at Isle Perrot on the first of June, 1872, which was numerously attended.

On the spot, Dr. T. Sterry Hunt gave an account of the history of the Island, as well as a popular description of the Geology of the District. Mr. Whiteaves explained the nature of some of the fossils to be met with in the adjacent Potsdam sandstone and calciferous Sand-rock, and Dr. J. Baker Edwards made some remarks on the topography of the surrounding country.

Prizes having been offered for the best Zoological or Botanical collections made during the day, the awards were made as follows:

1. For the largest named collection of animals, plants, or fossils.—open to all. Mr. J. B. McConnell, 70 species of flowering plants.

2. Ladies Prize, for the best named collection of wild flowers. Miss Morgan, twenty species.

3. Children's Prize.—Master Selwyn, for 37 un-named species of flowers.

MONTHLY MEETINGS.

1st Monthly Meeting, held Oct. 28th, 1873.

A paper on the Ferns of Ceylon, by the President, G. Barnston, was read by the Rec. Secretary.

Principal Dawson made a communication on Fossil Footprints.

A portion of a paper on the Island of Cuba, by G. F. Matthew, was read by the Recording Secretary.

2nd Monthly Meeting. held Nov. 25th, 1872.

Major H. Mills and Alexander Robertson were elected members of the Society.

D. McEachran, V.S., then read a paper on the prevailing Disease among Horses.

After some remarks upon this topic by Principal Dawson and Dr. J. Baker Edwards,

Dr. P. P. Carpenter gave a verbal account of the life and labors of the late Dr. W. Stimpson, as a malacologist.

Some concluding observations by Principal Dawson, on this last subject, terminated the proceedings.

3rd Monthly meeting, held Dec. 30th, 1872.

A small collection of fresh water shells, made by Prof. Bell, at Fort Garry. was exhibited, and some remarks upon the species were made by Mr. Whiteaves.

Rev. Canon Baldwin, Dr. Wolfred Nelson, G. M. Dawson and John Taylor were elected resident members.

Rev. C. H. Paisley's paper on Post Pliocene Beds at Bathurst, N. B., was read by the Rec. Secretary.

Some comments and remarks on this essay having been made by Principal Dawson, and C. Robb,

The second paper on the list, "on the Geology of Huron Co., Ont.," by John Gibson, B.A., was also read by the Secretary.

Some discussion ensued. in which Principal Dawson, Prof. Bell and C. Robb took part.

4th monthly meeting, held Jan. 27th, 1873.

Rev. John Empson, and A. H. Foord, F. G. S, were elected ordinary members.

Mr. A. R. C. Selwyn, F.G.S., made a communication "on some points in the Geology of Vancouver and Queen Charlotte Islands."

Principal Dawson followed with a description of the Fossil Plants collected by Mr. Richardson.

Mr. E. Billings made some remarks on the animal fossils of the two islands.

Mr. Whiteaves also commented on the fossils exhibited, and also pointed out the salient features of interest in a small collection of recent shells from the same localities.

The President, (Mr. G. Barnston), gave an interesting account of the uses to which the Coast Indians put various marine mollusca. He congratulated Mr. Richardson on the fine series of fossils collected during the past summer, and moved a vote of thanks to Mr. Selwyn for bringing the subject before the meeting, which was carried by acclamation.

5th Monthly Meeting, held Feb. 24th, 1873.

Mr. Christian Hoffman was elected an ordinary member.

A paper "On the Huronian and Mineral-Bearing Rocks of Lake Superior," was read by Prof. R. Bell.

Some discussion followed after the reading of this communication, in which Principal Dawson, Messrs. Selwyn, Robb and the author took part.

Mr. Selwyn brought a series of rock specimens from Australia to compare with examples of the rocks and minerals from Lake Superior exhibited by Prof. Bell in illustration of his paper.

6th Monthly Meeting, held March 31st, 1873.

Dr. C. F. Davies, Messrs. C. Gibb and E. Sawtell were elected resident members, and John Gibson, B.A. (of Almonte, Ont.) a non-resident member.

Mr. J. F. Whiteaves read a paper "On recent Deep-Sea Dredging operations between Cape Rosier and the Magdalen Islands, with some notes on the marine fisheries of the Province of Quebec."

After some remarks by Principal Dawson and other members, the proceedings were brought to a close.

7th Monthly Meeting, held May 5th, 1873 (adjourned from April 28th, 1873.)

Mr. J. Fraser Torrance was elected an ordinary member.

A paper "On the Races of Northern Europe," was read by the Rev. Canon Baldwin.

The Acting President (Principal Dawson) in moving a vote of thanks to the lecturer, took occasion to point out the close connection existing between ethnological and anthropological researches and recent investigations into the newest stratified rocks

He claimed that the facts collected up to the present date in each of these fields of inquiry, and especially late discoveries at Mentone, all tend to throw doubts upon the great antiquity which some had assigned to the human family.

ADDRESS TO H. E. THE GOVERNOR-GENERAL.

On the occasion of His Excellency's first visit to Montreal, in October, 1872, the President and Rec. Secretary were deputed to call on His Excellency to request him to become the Patron of the Society, and to honour the Society with a visit. His Excellency, through his Private Secretary, kindly consented to become Patron of the Society, but regretted that in consequence of numerous engagements he would be unable to visit the Museum on this occasion, but hoped to do so at some future time.

At a subsequent visit to the city, the same deputation waited on His Excellency to invite him to inspect the Society's collection. His Excellency was again compelled to postpone his visit, but kindly consented to receive an address of welcome from the officers and members.

SESSION 1873-74.

ANNUAL MEETING.

The Annual Meeting was held on Monday evening, May 19th, 1873, the Rev. A. De Sola, LL.D., in the chair.

The minutes of the last Annual Meeting having been read, the address of the Acting President, Principal Dawson, LL.D., F.R.S., &c., was read by the Recording Secretary, as follows:

ADDRESS OF THE ACTING PRESIDENT.

Gentlemen,—Our present meeting closes the fortieth year of the existence of this Society, and it becomes us to consider to what extent the hopes of its founders, expressed in the motto, "*Tandem fit surculus arbor,*" have been realized. A tree that can boast of forty annual rings of growth, in the soil and climate of Canada, should have attained to a goodly stature, should extend a wide and grateful shade, and should have borne some good fruit. Looking back upon the origin of the Society, we must confess that our growth has been slow, and has not kept pace with that of the great business community of Montreal, nor with that of similar institutions in the larger cities of the United

States, where, in many cases liberal and public and private endowments have given a magnitude and stability to the operations of kindred societies, which we have not been able to attain to; and while we have many favors to acknowledge, it is my decided impression that the commercial and professional community of Montreal has not appreciated as it should the efforts of this Society, nor treated it with the liberality which it deserves. In a city such as this scientific workers are necessarily few; and the great majority of the people have little leisure even to give a passing attention to the objects of a society like this. Still those who do give to scientific pursuits either the intervals of leisure snatched from daily work, or the time which they may have earned for themselves or have inherited as a precious gift of fortune, are from their exertions in this way doubly valuable as members of society; and the professing and teaching naturalists whom we can number, are in their place indispensable both to our material and educational welfare. Further it is of great importance that the taste and intellect of all classes of the community should be cultivated by an acquaintance with natural objects; and the existence of a society of this kind is at once one of the sure marks of high taste and culture, to which the city can point with pride, and has a useful function in providing a rational means of employing leisure as a counteraction to low and degrading places of amusement which too often spring up with a vigor and luxuriance of growth disproportionate to that of literary and scientific institutions.

I consider it a matter of no small importance that our Museum represents to some extent the popular study of nature in this community. In the Zoology of Canada it is undoubtedly the most important collection in this country, and in other departments it has much of value and interest. It provides the means of preserving, determining and exhibiting remarkable and interesting specimens which would otherwise be lost. Its doors are ever open to all who wish to know anything of our natural productions, and to strangers who desire to obtain some acquaintance with the aspects of nature in this country. Our Museum has now reached a somewhat critical point in its history. When the Society removed into its present building, we seemed to have ample space for our then comparatively small collections. But the objects in our possession have grown until we are in need of much more room, and our collection is again beginning to be crowded, while we lack means to extend our accomodation or even to utilize by new and improved cases the space that we have. With some changes of arrangement and additional cases, our present building might contain and exhibit the collections of the Society for several years to come; but it would require an annual sum of at least $1,000 at the disposal of our curator, to provide for the necessary repairs, additions and extensions. Were the public sufficiently alive to the importance of the object, it should not be difficult to realize this amount either by annual subscriptions or by a permanent endowment. In any case we should be prepared to consider within a few years the necessity of enlarging our Museum.

Our Library has not kept pace with our Museum, and as it cannot in the nature of the case become a popular or general library, but must be mainly one for scientific reference and consultation, we are here again in a position which requires extraneous aid and endowments, or the contributions of a large number of members.

It seems evident, therefore, that if we are to emerge from the present slow and languid condition of our progress, we shall be obliged in the course of not many years to appeal to the liberality of the friends of science on a still larger scale than that which was necessary in the erection of our present building.

Our journal, the *Canadian Naturalist*, begins with this year the seventh volume of the new series—fourteen volumes in all having been issued. Its present volume is under the able editorship of Dr. Harrington; and our new arrangement with the publisher enables us to give the journal gratuitously to each of our members, a change which it is hoped will greatly increase their interest in the work of the Society. It is not saying too much to affirm that the *Naturalist* should be in every Canadian library. It is the only work that affords a complete view of what has been done in the Geology and Natural History of the Dominion during the past fifteen years; and in the case of all who wish to have means of reference with regard to the natural resources of our country, it must occupy a place side by side with the reports of the Geological Survey. That its list of subscribers is so small beyond the limits of the Society, is not creditable to the practical good sense of our people; since independently of other considerations there can be no question that the information which it annually contains would, in a practical point of view, many times repay its cost. Its present limited issue will in no great number of years, render it a scarce work, and I have no doubt that the time is not far distant when it will be difficult, if not impossible, to procure complete sets.

The work of our last session may be summed up in the course of Sommerville lectures, and in the papers read at our monthly meetings. The former course—as usual largely attended— embraced subjects of great interest, and we are much indebted to the lecturers for their gratuitous services in this matter to the Society. The list is as follows :—

SOMMERVILLE LECTURES.

1. The Natural History of Ore Deposits, by Dr. T. Sterry Hunt.
2. The Life of an Oyster from a Man's standpoint, by Dr. P. P. Carpenter.
3. The Aborigines of New Brunswick, by C. Robb.
4. Man's Life in Montreal from an Oyster's standpoint, by Dr. P. P. Carpenter.
5. The Furs and Fur-bearing Animals of Canada, by Prof. Bell.
6. On the Chemical characters of the water available for the supply of Montreal, by Dr. J. Baker Edwards.

For next year I would suggest that possibly in addition to the Sommerville Course, we might provide a course or courses of evening lectures, not gratuitous, and by means of which the finances of the Society might be recruited.

The papers read at our monthly meetings number twelve in all. Four of these, that on the Ferns of Ceylon, by the President, Mr. Barnston; that on the Island of Cuba, by Mr. Matthew; the account of the Life and Labours of the late lamented Dr. Stimpson, by Dr. Philip Carpenter, and that on the Races of Northern Europe, by Rev. Canon Baldwin, relate to subjects beyond our immediate field. The others were more or less Canadian in their scope. Dr. McEachran gave us the result of his observations on the remarkable and mysterious disease which, with such marvellous rapidity, attacked the horses over nearly all Eastern North America, and the facts relating to the transmission and symptoms of which throw no little light on epidemics which afflict our own species. Mr. Paisley contributed some notes on the Post pliocene of New Brunswick, and Mr. Gibson on the Geology of Huron County, Ontario. Mr. Selwyn kindly laid before us a valuable summary of the Explorations of Mr. Richardson in Vancouver and Queen Charlotte Islands, so rich in new fossils and geological facts; Prof. Bell gave us a similar resumé of the recent discoveries in the metalliferous rocks of the North and West of Lake Superior. To these great Western regions the eyes of all men are now turned; and the wonderful scientific and economic discoveries made in the western territories of the United States, with the first fruits already realized in our own western territories, stimulate our hopes and expectations. I have had occasion lately, in connection with the departure of my own son into these regions as one of the pioneers of scientific exploration, to look over the literature of western geology; and in doing so, I have been struck with the amount of good work achieved under difficult circumstances, in times previous to the annexation of these regions to Canada. I would mention in connection with this the names of Dr. Bigsby, one of the earliest, and Dr. Hector, one of the latest explorers of the west, as well as those of Richardson, Hind and others who come between. With reference to the first mentioned, who is still living and working ably and usefully, I may mention his admirable summary of the post-pliocene deposits in the west, published in the journal of the Geological Society many years ago, and I do so the more readily, as with reference to the theory of drift deposits, he anticipated much of what I have myself been endeavouring to illustrate in our journal in the investigation of this difficult subject. Dr. Bigsby's paper of 1851 is still well worthy of perusal in connection with what has been done subsequently by geologists in the United States and in this country.

My own contribution on fossil foot-prints I may pass over without remark; and in conclusion of this part of the subject would direct attention to the fact that Mr. Whiteaves has again represented Canadian science as a dredger in the deeper parts of the Gulf of St. Lawrence, reaching in this last expedition the deepest known part of the Gulf, and adding very considerably to our knowledge of its fauna and many new facts bearing on the distribution and habits of useful fishes. The work was prosecuted under some difficulties, the double task of watching poachers on forbidden fisheries and of dredging in deep water, being evidently too much for any one cruiser. In future if this work is to be prosecuted as it undoubtedly should be, a suitable craft should be put at the exclusive disposal of the dredging party for the summer months. If we are obliged to leave the wide ocean to the

Governments of Great Britain and the United States, Canada should at least have the credit of thoroughly exploring the Gulf of St. Lawrence, one of the most interesting inland seas in the world; and it is to be hoped that the Honorable the Minister of Marine and Fisheries will follow up in this matter the work he has so well begun.

I have considered it my duty, in this address, prepared, as you know, merely as the substitute of my aged friend, Mr. Barnston, one of the veterans in the study of natural history in this country, to dwell almost entirely on the special interests of the Society, and I would, in conclusion, earnestly bespeak in its behalf your warm and zealous countenance and aid, in order that it may enter on a new and vigorous career, and may in the year to come advance with aclerated rapidity and make itself more and more worthy of being the central and most important Society devoted to Natural Science in this Dominion.

I trust that those who have been the old and tried friends of the Society will still cling to its interests, and that the young naturalists who are rising up around us will add their fresh vigour and enthusiasm, so that the next year may be signalized by greater things than any which has preceded it. For my own part I am disposed to give more time and effort than heretofore, rather than less, to the interests of the Society, whether aiding in its management or in contributing to its scientific success.

The Chairman of Council, Mr. G. L. Marler, then read the following report of the proceedings of that body:

REPORT OF THE CHAIRMAN OF COUNCIL.

Your Council at the end of their year of office respectfully report as follows:

That the monthly meetings of the Society have not been very numerously attended—a fact greatly to be regretted and due perhaps to their having been called by postal cards, issued at the beginning of the year and containing a list of the meetings, with their dates. Your Council had hoped that this system would have attained its object, but it has apparently been unsuccessful.

Your Council suggest that for the ensuing year, arrangements be made as early in the season as possible for the papers to be read at the monthly meetings and for the Sommerville course of Lectures: in this way contributors would have ample time to prepare their subjects and there could be some system adopted as to the order of the papers, &c.

Several necessary improvements have been affected, a new furnace having been put in, double windows obtained for the Lecture room, and the drainage attended to—But there are others equally needed to which your Council beg to draw your attention. Foremost among these are the thorough cleaning which the staircase and the museum flat require and new additional cases for the Museum.

The rooms of the Society have been let for eighty days during the past year to the Ladies' Educational Association for which the Society have received $120 exclusive of attendance. A special tariff has lately been adopted by your Council for the hire of the rooms, it being so arranged that the rate shall vary according to the season and according to whether light or fuel is supplied or not. The Recording Secretary has been authorized to have cards printed explaining this tariff, and to have these put up in various parts of the building.

It is with much regret your Council has to report that during the past year only 14 new members have been elected. Special efforts should be made to increase the list of members during the coming session. The Library and Membership Committee, appointed some years ago, have so far apparently taken no action in the matter.

There have been about one thousand or more visitors to the Museum during the past year, a circumstance which it is thought is very encouraging.

The debt on the building has been reduced by $1000, as was stated to be the intention of the Treasurer at the last annual meeting. The donations to the Library and Museum have not been as liberal as heretofore.

This Spring, on the occasion of the Governor-General's visit to this city, an address was presented, to which a reply was forwarded by His Excellency, who has kindly consented to be its Patron.

Arrangements have been made with Messrs. Dawson Brothers, and approved by the Society, whereby Dr. Harrington undertakes to edit the 'Canadian Naturalist.' Under the new arrangement a copy will be supplied to each member gratuitously.

Your Council report that Messrs. Dawson Bros.' account of $653.92 is in a fair way of being reduced by special donations and by the collection of outstanding subscriptions to the journal.

That extra exertions should be used to get more Lady Associates, and that efforts should be made to collect their outstanding subscriptions.

The Council in retiring, desire to convey their thanks to the officers who have so efficiently carried on the business of the Society during the past year.

Montreal, 19th May, 1873.

The subjoined report of the Scientific Curator and Recording Secretary, was next read by Mr. Whiteaves.

REPORT OF THE SCIENTIFIC CURATOR AND RECORDING SECRETARY.

During the greater part of the past Session, the work done has been of an almost purely scientific character. After the last annual meeting, active preparations were set on foot towards carrying out a second deep-sea dredging expedition to the Gulf of St. Lawrence. Before leaving the city, as the Society had pledged itself to give the fullest publicity to the results already obtained in a previous expedition, two papers embodying the latest studies of myself and others on the specimens collected were written. One of these was kindly read by Dr. Nicholson of Toronto, at the last meeting of the British Association, and the other was published in the 'Annals of Natural History' for November, 1872. The months of July and August were spent in the prosecution of deep-sea dredging operations in the Gulf. The task was beset with many unforeseen difficulties, and the time wasted, so far as I was concerned, was considerable. Still, the number of new and rare specimens collected was very large, and many new facts bearing directly on the sea fisheries of that region, were amassed. Such books as were not accessible here, but which were essential to the correct identification of these marine invertebrates, were ordered from England, and most of the remainder of the session was devoted to the careful examination of these specimens. A somewhat elaborate report on the results of the second series of investigations, was written for the Minister of Marine and Fisheries, and submitted on behalf of the Society. The document (of which copies are lying on the table) makes a pamphlet of 22 pages royal octavo. Besides some introductory matter, it contains, 1st, a diary kept during my absence, shewing how the time was spent; 2ndly, as careful an account as possible of the many specimens collected; and lastly, a series of observations on the sea fisheries of this Province, and on other practical subjects. Although doubtless very imperfect, it is yet hoped that on the whole this report will reflect no discredit either upon the Society which I have the honour to represent, or on the Minister under whose auspices these investigations were conducted.

In order to shew that during the past session important additions have been made to our knowledge of the marine zoology of this Province, the following details may not be out of place.

FORAMINIFERA.—These microscopic organisms have been partially studied. The novelties detected are not very numerous so far. About ten new species or varietal forms can now be added to the latest list published.

POLYCYSTINA.—The few species collected in 1872 are precisely the same as those dredged in 1871.

SPONGES.—There are about ten species new to our fauna in the series collected last year. These are unusually curious and interesting. An attempt has been made to work up the whole group, and portions of many have been boiled in nitric acid, and the spicules carefully examined. The subject is one of great difficulty, however, and the trouble may be referred partly to the want of a series of accurately named British species for comparison, and partly to the fact that most of the sponges of the lower St. Lawrence are in all probability new to science. The appearance of Dr. Wyville Thompson's new book, 'The Depths of the Sea,' has thrown some light on several of these sponges. It is clear that some of the genera and species described in this volume are identical with specimens dredged in deep water in the St. Lawrence last year.

HYDROZOA.—These simple corallines have been carefully examined and studied. Twenty-three species have been recognised in last year's collection, and it is estimated that about ten more have yet to be identified.

ACTINOZOA.—The eight or ten additional species in this group have been studied by Prof. Verrill and myself. The three kinds of *Alcyonium* collected are not yet determined with any great degree of certainty; one is apparently undescribed, as is also a sea anemone of the limited genus *Actinopsis*.

ECHINODERMATA.—The sea urchins and star fishes of the Gulf have also been critically re-examined, and a list of them published. The number at present known to inhabit the Gulf north of the Bay des Chaleurs, is about twenty-eight, nearly half of which are now for the first time recorded as denizens of our waters. Three critical species require further elucidation.

ANNELIDA.—All the marine worms collected in 1871 and 1872, have been sent to Dr. W. C. McIntosh (of Murthly, near Perth) a well-known authority in this little studied group of animals. About twenty-four species have been already named, and in a short time it is hoped that the whole series will be identified. The collection made in 1872 is larger, and contains more species than that obtained in 1871.

CRUSTACEA.—Thirty species of Crustacea, collected last summer, have been named. Mr. S. J. Smith (of Yale College, Newhaven, Conn.) has kindly identified those which I had no opportunities of determining here. Most of the species are new to the seas of the Province of Quebec.

TUNICATES.—The Tunicates collected, with two exceptions, were sent to Prof. Verrill, who has made a special study of these animals. So far ten species have been identified.

POLYZOA.—This group has been partially studied and worked up by myself. About forty species have been made out with tolerable precision, but there is little doubt that the list will be greatly increased by a closer and more rigorous examination.

MOLLUSCA.—All the sea shells obtained last year have been critically examined and determined. About 150 species of marine testacea are now known to inhabit the seas of this Province.

FISHES.—In conformity with a request from the Minister of Marine and Fisheries to that effect, special attention was paid to the collection of facts bearing directly or indirectly upon the sea fisheries of the Dominion. With what success this part of my mission has been attended, those who have taken the trouble to peruse my report to the Government must decide.

To sum up this portion of my report, about ninety species of marine animals, new to the Canadian fauna, have been collected, studied and determined during the past year. These have either been mounted on tablets, if dry preparations, or put into separate bottles with alcohol, if the nature of the specimens required that mode of treatment. The strain upon the eyes caused by prolonged use of towing nets at sea, and in protracted microscopic work at the office, has been considerable. The correspondence involved, in order to attain successful results, has also taken up much time.

It is much to be regretted, that in consequence of lack of funds, the Society has not been able to provide suitable cases, in which these and other alcoholic preparations can be exhibited to the public. At present the collections made in 1871 and 1872, as well as many other objects of great scientific interest and value, are almost unavailable to the student, and are wholly so to the general run of visitors, for want of proper accommodation.

At intervals, when my eyes required rest, after close application to the microscope, some progress has been made in mounting my own collection of shells for the use of those who wish to consult it. About 300 species have been mounted on tablets and labelled.

During the past year the donations to the Museum have been unusually small. So far as birds and mammals are concerned, this may have arisen from the state of the law on the subject. During the last session of the Quebec Legislature, efforts were made to induce the Goveanment to permit the granting of licenses to enable naturalists to procure specimens of birds or their eggs for bonâ fide scientific purposes. Through the kindness of the Hon. James Ferrier, one of the most generous benefactors to this Society, the requisite clause was inserted in the Act for the protection of insectivorous birds. It is hoped that the effect of this measure will ultimately be to largely increase the Society's collection of native birds and mammals.

An interesting series of the *Muridœ* (mice, meadow-mice, rats, &c.) of this Continent has been received from the Smithsonian Institute, carefully named by Dr. Elliot Coues. The collection contains many species new to our Museum, and would have been a most valuable addition to the few North American mammals in our cases, but unfortunately the skins are so badly preserved that it was found to be impossible to mount them for public exhibition.

As a cheering omen for the session just about to commence, it may be mentioned that advices have just been received of a donation of sixty specimens of East Indian birds from Major G. E. Bulger, who has previously given many valuable and interesting donations of objects of various kinds from that part of the world. The consignment has been shipped by the Scandinavian, and may be expected at an early date.

The additions to the library are about equal to the average of other years. The most important of them are illustrated monographs on the sponges, hydrozoa, zoophytes, and sessile eyed crustaceans, purchased with a special view to working up the St. Lawrence species. Every year the Society becomes better known and appreciated by kindred associations in Europe and the United States. Did our finances permit, there are few scientific bodies in either of these countries with whom we should not exchange periodicals, reports, &c. For this and for other reasons an amount of correspondence is involved which occupies more and more of my time every year.

Gentlemen,—the session which is now brought to a close terminates the first decade of my association with this Society. I am free to admit that, reviewing the past ten years, the hopes that I once entertained as to the future of this Institution have not been realized. The success or failure of this Society in particular affords, as it seems to me, a fair criterion of the value which the inhabitants of the city set upon higher education generally. Yet how lamentably small has been the support or aid accorded to the Society by our wealthy citizens. For the last three years it has laboured under such a pressure of pecuniary difficulties that during that time literally nothing has been spent on either the Museum or Library. The Hall, the Gallery and Museum have never been properly cleaned since the building was erected, and improvements which are most urgently needed have been found impracticable, and abandoned for want of funds. That some interest is taken in the work which we are engaged in attempting to further, is manifest from the fact that upwards of 1000 persons have visited the Museum during the past twelve months. Were our collections made more worthy of this commercial and wealthy metropolis, and the building thrown open freely to the public, it is reasonable to suppose that the number of visitors to the Institution would be very largely increased. I should not have ventured to offer these remarks, especially as similar ones have been dwelt upon in the able address of the Acting President, but that I had a special object in so doing.

My desire has been to shew how many difficulties and obstacles I have had to contend with in the proper carrying out of the trust which for ten consecutive years you have reposed in me. Due allowance being made for many shortcomings and deficiencies in the past, it is yet confidently hoped that if the work done during so long a time has been less than it ought to have been, the fault is largely attributable to that want of liberal patronage which might well have been accorded to a Society so deserving of the sympathy and practical assistance of all classes in the community.

J. F. Whiteaves, F.G.S., &c.

The Treasurer, Mr. James Ferrier, jr., submitted the following financial statement, and gave some verbal explanations of various details connected with it.

Dr. THE NATURAL HISTORY SOCIETY *in Account with* JAMES FERRIER, Jr., *Treasurer.* Cr.

1872-73.	RECAPITULATION.	
To Balance due the Treasurer, May 1, 1872		$33 57
To Cash paid	J. F. Whiteaves, salary	400.00
" "	S. W. Passmore, "	200.00
" "	Mr. Pell, commission	31.65
" "	Interest	60.00
" "	for Coal and Wood	220.61
" "	" Gas	29.04
" "	" Water	38.50
" "	" City Taxes	49.25
" "	" Insurance	62.00
" "	Repairs, and petty expenses	282.32
" "	Books, printing and advertising	256.44
" "	Loss on Field Day	0.30
" "	Dredging expenses	488.94
" "	for New Furnace	132.50
1873. May 1.—To balance in Treasurer's hands		0.60
		$2285.72

1872-73.	RECAPITULATION.	
By Cash rec'd.	annual Government Grant	$750.00
" " "	Government Grant on Dredging account.	500.00
" " "	Collected by Messrs. Barnston and Watt for Dredging expenses of 1871	100.00
" " "	Members' Yearly Subscriptions	645.00
" " "	Subscriptions to 'Naturalist,'	12.00
" " "	Museum Entrance Fees	51 97
" " "	Rent of Lecture Room	226.75
		$2285.72

LIABILITIES—May 1st, 1873.

Royal Institution	$1000.00
Dawson Bros.	536.00
Petty Accounts	28.69
	$1564.69

Errors and omissions excepted.

(Signed) JAMES FERRIER, Jr.

Montreal, May 16th, 1873.

Rev. Dr. De Sola made some remarks on the reports submitted, and urged the necessity of trying to popularize the papers read at the monthly meetings and the Somerville lectures.

Dr. J. Baker Edwards asked if any arrangements had been made for holding a field day shortly, and pointed out the importance of continuing these pleasant social gatherings, as well as the desirability of trying to interest ladies in the work of the Society.

It was moved by L. A. H. Latour, seconded by H. Rose, and resolved:

"That the reports just read be adopted, printed and distributed to the members."

On motion of Dr. De Sola, seconded by Dr. J. Baker Edwards, it was unanimously resolved:

"That Dr. T. Sterry Hunt, F.R.S., be elected an honorary member of the Society."

It was moved by His Lordship the Metropolitan, seconded by James Ferrier, jun., and resolved:

"That the thanks of the Society be voted to Principal Dawson for the preparation of the annual address."

The following resolution, having been moved by G. L. Marler, and seconded by R. McLachlan, was adopted unanimously.

"That the Rule relating to the election of officers be suspended, and that Principal Dawson be elected President."

Similar resolutions having been duly moved, seconded and adopted, the following officers were re-elected by acclamation:

Treasurer—James Ferrier, jun.

Cor. Secretary—Prof. P. J. Darey, M.A., B.C.L.

Scientific Curator and Rec. Secretary—J. F. Whiteaves, F.G.S., &c.

Messrs. G. L. Marler and Prof. P. J. Darey having been appointed scrutineers, the balloting for the remaining officers was then proceeded with, and the following results were announced:

Vice-Presidents—Rev. A. De Sola, LL.D.; Sir W. E. Logan, LL.D., F.R.S.; G. Barnston; C. Smallwood, M.D., LL.D., D.C.L.; A. R. C. Selwyn, F.G.S.; E. Billings, F.G.S.; His Lordship the Bishop of Montreal and Metropolitan; C. Robb.

Council—G. L. Marler, D. A. P. Watt, J. H. Joseph, Prof. R. Bell, E. E. Shelton, D. R. McCord, Dr. B. J. Harrington, and the Rev. Canon Baldwin.

On motion of G. L. Marler, seconded by J. H. Joseph, the following gentlemen were elected to serve as a library and membership Committee: Dr. J. Baker Edwards, Dr. John Bell, D. McEachran, G. T. Kennedy, and L. A. H. Latour.

GEOLOGY, PALÆONTOLOGY AND MINERALOGY.

Report of the Geological Survey of Canada for 1871–72. A. R. C. Selwyn, F.G.S., Director.—This volume is one of special interest, as it contains accounts of explorations by the Geological Survey in the regions beyond the "Mountains of the Setting Sun,"—regions rocky and grand, but as yet little studied by the geologist.

Besides a summary Report by Mr. Selwyn, indicating the general progress of the Survey, the volume contains the following:

1. Journal and Report of preliminary Explorations in British Columbia, by Mr. Alfred R. C. Selwyn.
2. Report on the Coal-fields of the East Coast of Vancouver Island, with a map of their distribution, by Mr. James Richardson.
3. Report of progress in Exploration and Surveys of country between Lake Superior and the Albany River, by Mr. Robert Bell.
4. Preliminary Report of Exploration and Surveys in the country between Lake St. John and Lake Mistassini, by Mr. Walter McOuat.
5. Progress Report of Exploration and Surveys in the Counties of Leeds, Frontenac and Lanark, in the Province of Ontario, with a plan of the Township of Marmora, showing the position of the worked Gold Mines, and the course of the Auriferous Zone, by Mr. H. G. Vennor.
6. Report of progress in Geological Investigation in New Brunswick, by Professor L. W. Bailey.
7. Summary of Statistics of Mines and Mineral Produce of the Dominion, prepared from Official Returns and other sources, by Mr. Charles Robb.

From Mr. Selwyn's Journal we learn the more than ordinary difficulties with which the geologist has to contend among the rugged hills and rushing streams of British Columbia.

In his report upon the geological structure of the country, Mr. Selwyn gives the following as a provisional classification of the rocks:

I. *Superficial Deposits.*
II. *Volcanic Series and Coal and Lignite Group of the Man-land; and the Coal-rocks of Vancouver Island.*
III. *Jackass Mountain Conglomerate Group.*
IV. *Upper Cache Greek Group (Marble Canon Limestones).*
V. *Lower Cache Creek Group.*
VI. *Anderson River and Boston Bar Group, and Upper Rocks of Leather Pass and Moose Lake.*
VII. *Cascade Mountain and Vancouver Island Crystalline Series.*
VIII. *Granite, Gneiss and Mica-schist Series* of North Thompson, Albreda Lake and Tête Jaune Cache, including the micaceous schists of the Cariboo district.

Each group is then described in detail, and amongst other points it is interesting to note the highly crystalline character of many of the rocks which are shewn from their fossils to be of comparatively recent date. Mr. Selwyn's report contains a number of valuable facts with reference to the soil, forests, game, &c., of British Columbia, and concludes with the following remarks:

> "Though British Columbia possesses considerable tracts of fine "agricultural and pastoral land, amply sufficient to produce all the "food her own population is ever likely to require, yet it is not "probable that she will ever hold a prominent position as an exporting "agricultural country. Her chief resourses are her forests, her fisheries "and her mines; and these are capable of almost unlimited develop-"ment. Her gold-fields, her silver veins and her coal-mines are yet "in their infancy; her timber trade is in a similar condition, and her "fisheries, which may fairly be expected to rival those of the Atlantic "Provinces, have not yet extended beyond the supply of local reqire-"ments.
>
> "There can scarcely be a doubt in the mind of any one who has "visited the country, that a bright and prosperous future is in store "for the Alpine Province of the great Dominion; only to be realised, "however, when the iron road shall have brought her into closer com-"munion with her elder sisters in the east."

Mr. Richardson's report contains much useful information about the coal-fields, as well as about the crystalline rocks, superficial deposits, crops, &c., of Vancouver Island. It is followed by a note by Dr. Dawson on the fossil plants collected by Mr. Richardson, and by analyses and notes, by Dr. Hunt, upon samples of coal and crystalline rocks from Vancouver Island.

We have not space to say much of the remaining reports, though they are all valuable and interesting. Those interested in the economic geology of Ontario will do well to consult Mr. Vennor's report, which contains notes on the iron ores of Frontenac, Leeds and Lanark; on the phosphate of lime in North Burgess, Bedford, and South Crosby; and on the gold of Marmora.

The mining statistics form a new feature in the Reports of the Survey, the importance of which cannot be over-estimated. Some of the figures given in the tables are undoubtedly too low; but this is explained by the difficulty experienced in obtaining complete returns from persons engaged in mining.

A MANUAL OF PALÆONTOLOGY. By Henry Alleyne Nicholson, M.D., &c., &c., Professor of Natural History, University College, Toronto.*

This is a well executed and well illustrated octavo of 600 pages, presenting to the student a comprehensive, and, on the whole, accurate view of the subject of fossil organic remains, whether animal or vegetable. The introductory chapters contain some valuable general views on the subject of geology in its relations to palæontology, after which the author proceeds to take up his main subject, that of fossil animals, arranged in zoological order. The classification is that of the modern English school of zoology, for whose shortcomings Dr. Nicholson is not to be held responsible, as no writer of an educational work on natural history for use in Great Britain can hope for success unless he conforms to the prevalent London fashion. Prof. Nicholson, however, rises altogether superior to this school in the wide view which he takes of his subject, giving importance not only to European but also to American fossils, and thus rendering his work of far more value to the student in this country than any other English manual. Every group of animals to which we have had occasion to refer in this part of the Manual, is clearly and well represented.

The part devoted to fossil botany is less copious; but students of that important but neglected subject may be thankful to find it represented at all, and on the whole a good general view is given of the successive floras, which are treated not in botanical but in geological order, an arrangement which has important advantages, and might be applied to zoological palæontology as well.

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* Blackwood & Sons, Edinburgh.

The concluding part of the work gives a good summary of historical palæontology, and there is a useful glossary and a copious index. On the whole the work can be strongly commended to Canadian teachers and students, and to all those who are endeavouring with such aid as they can obtain from books, to form collections of fossils. D.

THE SUPPOSED DIAMONDS IN XANTHOPHYLLITE.—Considerable interest was excited a short time back by M. Jeremejew's announcement that he had discovered diamonds imbedded in a rare Russian mineral known as Xanthophyllite. Wishing to verify Jeremiejew's observations, Dr. Knop, of Carlsruhe, has been quietly working at the subject, and has recently come to to the conclusion that the so called crystals of diamond are merely angular cavities, suggesting, it is true, the well-known forms in which the diamond is wont to crystallize, but nevertheless destitute of the veriest trace of diamond, or of any other mineral substance. It might, however, be fairly supposed that the cavities, though now empty, originally contained certain crystalline materials which impressed their angular form upon these hollows. Some curious experiments by Knop lead, however, to an opposite conclusion. He obtained thin sections of xanthophyllite, which, when magnified 1500 diameters, appeared to be absolutely destitute of any of these angular cavities; nevertheless, after treating the preparation with sulphuric acid, numerous cavities were recognized exactly similar to those referred in other cases to the presence of diamonds. In other experiments, fine lamellæ of xanthophyllite were carefully examined in all directions under the microscope, and the entire absence of any crystalline impressions then determined; the object was then touched with a few drops of concentrated sulphuric acid, and heated until white fumes appeared. The preparation, when cooled, was protected with a cover glass, and placed under the microscope, when it exhibited swarms of beautiful tetrahedral cavities, sharply defined, regularly formed, and arranged in parallel rows. From these and other observations, the author feels justified in concluding that the angular cavities in the Russian xanthophyllite have nothing to do with the presence of diamonds, but owe their origin merely to the corrosive action of acids.—*Quarterly Journal of Science.*

A MARYLAND OIL WELL.—A few years ago an oil well was started near Cumberland, Maryland; but instead of striking oil, the pioneers came upon a gas chamber, and penetrated it. The gas was ignited, and continued burning. About a year ago, Mr. Haworth, of Boston, purchased the well, and obtained a patent for the manufacture of carbon. The gas is allowed to burn against soapstone plates, on which the carbon is deposited in the form of soot. Six hundred and sixty burners are now in operation, each burner consuming eight cubic feet per hour. By a mechanical arrangement, the soot is scraped and deposited in large tin boxes about 3 feet long, 1½ feet wide, and 1½ feet deep; scrapers are passed along the soapstone plates every twenty minutes, and the boxes are filled on their fourth passage. A building twice the size of the present one is now in course of construction. It will have in use 1328 gas burners. The present consumption of gas amounts to about one-twelfth the whole quantity escaping from the well. The total consumption of gas by the burners of both buildings will be one-fourth of the whole. The carbon is generally used for the manufacture of ink.—*Quarterly Journal of Science.*

BOTANY.

HOME BOTANY.—It is to be regretted that although every year a considerable amount of botanical research is made in the neighbourhood of Montreal, few results are chronicled. In this way much local botanical knowledge is lost, and much time is expended by new enthusiasts in finding out what had already been known to former workers in the same department. Inasmuch as the natural productions of one's own vicinity are of much greater interest than those of parts more remote, so it is allowable for Montreal botanists to study with peculiar enthusiasm the flora of the mountain and regions lying within reach of a day's excursion. If the interesting discoveries that are made from year to year by new and older investigators in this limited and well-searched area, were regularly published in our local scientific magazine, the accumulated facts would gradually give us a thorough knowledge of the flora of the district, which would serve as an exploring shaft into the vegetable products of the country, to shew their nature from the highest to the lowest forms. The thorough study of such a district is of higher scientific value than the superficial investigation of a whole province. The improvements taking place in this vicinity are producing great changes in the flora, causing the disappearance of many rare and beautiful species, and the introduction of hardy and noxious weeds. As time goes on, the houses, creeping out block by block from the narrow area enclosed by the walls in olden times, fill up the vacant lots and fields. By degrees new drains and tunnels are drying up the pools where the pondweeds grew, and duckweed mantled the surface o'er with green, and the swamps and ravines no longer afford the moist and shady home for the orchids and moccasin flowers of former years. Further away from the din of busy industry, the farms and market gardens are rapidly encroaching on the woods and copses, while these again are being robbed of their pristine character by the constant incursions of men and cattle, and thus, soon, the lover of flowers may look in vain for our sweet-scented pyrolas and slipper-plants, and be forced to say in the words of the old Scottish song,

> "The flowers of the forest are a' wede awa'."

So rapidly is this process of encroachment on rural parts going on, that sometimes plants essentially of the country and fen, are surrounded and imprisoned by the advancing lines and forming squares of houses. Thus, specimens of the marsh five-finger, and buckbean or swamp gentian, and other swamp plants, could be seen only a year ago growing in a boggy lot between Richmond square and the R.R. track. The following are some examples which occur at the moment, of particular localities where somewhat uncommon species of plants may be found: *Orchis spectabilis*, ravine head of University street; *Viola Selkirkii*, amongst loose rocks at the base of the east end of the Mountain; *Viola sagittata*, rising ground back of Hochelaga village; *Viola lanceolata*, near Mde. Bruneau's, Montarville; *Atragene Americana*, brow of mountain above Ravenscraig, and summit of Belœil mountain; *Uvularia sessilifolia*, top of the Mountain, above Terrace Bank; *Cratægus oxycantha*, the English hawthorn, St. Helen's Island; *Claytonia Virginica*, woodland at the base of the east end of the Mountain, near the cemetery fence; *Aralia trifolia*, swamp in the cemetery; *Aspidium fragrans*, exposed rocks near the lake, Belœil Mountain.

These may furnish some localities new to many collectors in this neighbourhood, and other localities of somewhat rare species will be furnished in future numbers. Any one making known the occurrence of uncommon species in particular localities will contribute much to the common knowledge of the flora of the district, and add greatly to the pleasure and profit of excursions and rambles in the neighbourhood of Montreal. J. B.

CHEMISTRY.

WATERS OF PRINCE EDWARD ISLAND.—In Dr. Dawson's Report on the Geological Structure and Mineral Resources of Prince Edward Island, published in 1871, attention was called to the deficient supply of water to Charlottetown, and suggestions offered with regard to obtaining a supply by means of boring. The question is one of much importance and has been too long neglected, for much of the water at present used there is totally unfit for drinking purposes. The 'American Chemist' for May, 1873, contains the following note by S. D. Hayes, of Boston:

"There is probably no city of ten thousand inhabitants on this continent, that is suffering more for want of pure water than Charlottetown, the capital of Prince Edward Island. The public and private wells of this city are unfit for use from the presence in them of animal matters in uncommonly large proportions, and they undoubtedly constitute the primary cause for some of the diseases prevailing among the people there. The inhabitants of this city are literally dependent upon a water cart or two and a spring just outside of the city limits for every drop of water fit to use for cooking or drink; and this water, which is itself not by any means of the best, is sold from the carts for nearly one cent per gallon. For more than two years the City Council have had this matter under consideration, and the first complete analyses of their waters were made in November, the sources of the different specimens being unknown at the time. In recording only partial results of these analyses, it should be understood that the constituents called *organic matter*, consist of the volatile matters after correction and deduction of carbonic and nitric acids, water of composition, etc., belonging to the mineral and saline constituents determined by full analyses.

One United States gallon (231 cubic inches) of these waters contained in grains:

Source of waters analysed.	*Inorganic matter.*	*Organic matter.*	*Total weight of residue.*
City pump well	50.61	5.95	56.56
Park spring	5.05	3.17	8.22
Winter river, six miles from the city.	4.21	2.46	6.67

The well water contained nitrate of potash in sufficient quantity to admit of its separation by crystallization; and the predominant constituent in the other specimens was sulphate of lime.

There is now every reason to suppose that the water of Winter River will be brought into Charlottetown before long, through a proper system of supply pipes, although the same partisan feeling on the 'water question' finds expression there as elsewhere.

ESTIMATION OF PHOSPHORIC ACID.—As our deposits of apatite continue to be opened up, a rapid method for the determination of the percentage of phosphoric acid will become more and more a desideratum. Several articles have recently appeared on this subject in scientific journals, and the following abstract of one of them is given in the Journal of the Chemical Society for March*:

"Two grams of the phosphate to be examined are treated at the ordinary temperature with 50 c.c. of dilute hydrochloric or nitric acid, the solution is filtered, and the filtrate treated with citric acid, and then with excess of ammonia; the phosphoric acid is then precipitated with solution of magnesium chloride in excess, whereby the precipitated ammonio-magnesium phosphate is made to subside more rapidly than it would otherwise do The supernatant liquid is now separated from the precipitate by means of an aspiration-filter, and the precipitate is washed with ammoniacal water, which is afterwards removed by the same means. The precipitate is next dissolved by means of a few drops of nitric acid and the phosphoric acid estimated with uranium acetate solution, according to a modification of Leconte's method.

Boussingault has stated that an excess of ammonium citrate holds in solution a considerable portion of the ammonio-magnesium phosphate; but the author finds that by using not more than 80 to 100 parts of citric acid to one of phosphoric acid contained in the substance, no loss is experienced.

He also finds that by adding excess of magnesium chloride, keeping the proportion of citric acid within proper limits, adding the right quantity of ammonia in excess, and not allowing the total volume of the solution to exceed a certain amount, accurate results can be readily obtained in presence of lime, iron and alumina."

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* Any one interested in this matter should consult Joulin's paper in the 'Chemical News' for May 9th.

THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

ON THE GEOLOGICAL RELATIONS OF THE IRON ORES OF NOVA SCOTIA.

(Read before the American Association for the Advancement of Science.)

By J. W. Dawson, LL.D., F.R.S.

The Iron Ores of Nova Scotia, long neglected, have recently begun to attract the attention of capitalists to an extent in some degree commensurate with their importance. The magnitude and variety of the deposits, the great richness of the ores, their proximity to the Atlantic and to great deposits of coal, are all features which give them very great economic value, and must eventually cause them to take no small part in contributing to the iron supply of the world. My purpose in the present paper is, with the aid of recent researches in which I have been occupied, to give a concise summary of the geological position and mode of occurrence of the principal deposits, and more especially of those facts which have been developed since the publication of my "Acadian Geology."

If we arrange these deposits in the first place under the two heads of *Beds* conformable to the stratification and *Veins*, we shall find that the former occupy three distinct geological horizons—that of the Lower Helderberg or Ludlow in the upper part of the Silurian, that of the Oriskany at the base of the Devonian, and that of the Lower and Middle Carboniferous. The latter occur in altered rocks which may be assumed to be of

Silurian age, in the Lower Carboniferous, and at the junction of these two groups of rocks. We may shortly consider the deposits of these several kinds and ages in their order.

1. Bedded Ores.

(1) *Great Hematite Bed of the Lower Helderberg Series.*

This, in so far as at present known, is most extensively developed in the vicinity of the East Branch of the East River of Pictou, and on the upper part of Sutherland's River. Here the rocks which rise unconformably from beneath the Carboniferous beds of the Pictou coal-field, consist in great part of gray and olive slates, usually coarse and unevenly bedded, and with occasional calcareous bands, holding the characteristic fossils of the "Arisaig group," a series in Nova Scotia equivalent to the Lower Helderberg of American geologists, though in its specific forms more nearly allied to the English Ludlow than to groups of this age on the great inland plateau of America. These beds are affected with slaty cleavages, highly inclined, much faulted, and folded in abrupt anticlinals, so that their detailed arrangement has not yet been satisfactorily traced. The great ore-band which forms one of the most conspicuous marks for unravelling their complexities, has been traced mainly along two distinct lines of outcrop, both somewhat curved and broken, and which seem to lie on the opposite sides of an anticlinal axis. It has also been recognized in two other localities where it must come up on distinct lines of outcrop, the precise relation of which to the others has not yet been ascertained.

The ore bed is accompanied by a thick band of olivaceous slates, and beneath this there appears hard ferruginous quartzite which Dr. Honeyman compares to the Medina sandstone. Lower than this and possibly unconformable to it are black and greenish slates with bands of quartzite and soft chloritic and nacreous schists which as yet have afforded no fossils. They are associated with hard beds or masses of rock rising into some of the highest eminences, and which have usually been described as trap, but which seem to consist for the most part of an indurated slaty breccia or conglomerate, corresponding very nearly in character to the typical graywacke of the older German geologists. These rocks may be of middle Silurian age, though possibly in part older, and we shall meet with them again in connection with the great vein of specular iron.

The ore-bed where most largely developed attains a thickness of about thirty feet, and in places where it has been opened up by exploratory works, it has been found to afford from ten to twenty feet in thickness of good ore. This ore is a red hematite, sometimes compact and laminated, but more frequently of an oolitic character occasioned by the arrangement of the peroxide of iron in minute concretions enveloping grains of sand. By the increase of these silicious grains it passes in the poorer portions into a sort of ferruginous sandstone. Similar beds of fossiliferous ore are well known to occur in the Clinton group of New York and Pennsylvania, and Prof. Hall informs me that they are found also in the Lower Helderberg series of New York.

Along the different lines of outcrop above referred to, this bed has been traced for several miles, and being of a hard and resisting character, it rises into some of the higher elevations of the country. Though not one of the richest ores of the district, its great quantity and accessibility render it highly important for practical purposes. The analyses made of it show a percentage of metal varying from 43 to 54 per cent. The foreign matter is principally Silica, and the proportions of Phosphorus and Sulphur are small—one of the specimens analyzed affording none whatever, another .22 Phosphoric Acid and .29 Sulphur. These analyses were made at the instance of Mr. E. A. Prentice, now organizing a company to work this and other deposits in the district. The principal exposures of this bed are distant only twelve miles from the great collieries of the East River of Pictou, and less than ten miles from the Pictou and Halifax Railway. This deposit was first described by Mr. R. Brown in Haliburton's History of Nova Scotia, 1829, and subsequently by the writer in Acadian Geology. More recently exploratory works have been carried on and a practical report made by Mr. G. M. Dawson, Associate of the School of Mines, London; and the bed has been traced and collections of its fossils made by Mr. D. Fraser of Springville.

(2) *Hematite and Magnetic Iron of Nictaux and Moose River.*

This deposit takes us to the other extremity of Nova Scotia, and brings us a stage higher in geological time, or to the period of the Oriskany Sandstone. It would indeed appear that the conditions of ore-deposit so marked in Eastern Nova Scotia in the upper Silurian, were continued in the western part of the Province into the Devonian. In many specimens of the Nictaux ore the chief apparent difference as compared with that of Pictou is in the contained species of fossils.

Where I have examined this bed, it appears to be six feet thick and enclosed in slaty rocks not dissimilar from those associated with the Silurian ore of Pictou. Recent explorations at Nictaux are said to have developed extensions of this deposit; but I have no details of these. As rocks of the Arisaig group are known to underlie the Nictaux beds, it is not impossible that additional beds of ore may be found in these. The normal condition of the iron of the Nictaux bed is that of peroxide; but locally it has lost a portion of its oxygen and has become magnetic. This I believe to be a consequence of local metamorphism connected with the immense granite dikes which traverse the Devonian rocks of this region.

The Nictaux ore is more highly fossiliferous than that of Pictou, and contains a larger proportion of Phosphate of Lime. In the attempts hitherto made to work this ore, the distance from coal has been a main disadvantage, but the construction of the Windsor and Annapolis railway has diminished this. The Devonian beds holding this bed are described in "Acadian Geology." An analysis of a specimen made many years ago gave 55 per cent of iron.

(3) *Bedded Ores of the Carboniferous System.*

The most remarkable of these is a bed of crystalline *Spathic iron* or Siderite, occurring in the Lower Carboniferous series, near Sutherland's River in the County of Picton. As described by Mr. G. M. Dawson, who prosecuted works of exploration in it last year, it is a conformable bed, occurring in the Lower Carboniferous red sandstones, and varying from six feet six inches to ten feet six inches in thickness. It is accompanied with smaller bands of the same mineral, and at no great vertical distance from it is a bed of gypsum. Its mode of occurrence is on the whole not dissimilar from that of the non fossiliferous sub-crystalline limestones which occur in some parts of the Lower Carboniferous series associated with the gypsum. This ore is a true Spathic Iron, granular and crystalline in texture, and when unweathered of a light gray colour. It affords from 42 to 43 per cent. of iron and contains from 2 to 8 per cent. of manganese. This bed is only four miles distant from the "Vale" colliery, and is intended to be worked in association with the Hematite already described, and with the other ores on the East River of Pictou possessed by the same proprietors. From the Report of Mr. Andrews on the second geological district of Ohio, it would appear that similar beds, though on a smaller scale, occur in the Lower Carboniferous series of that State. In Nova Scotia this bed is at present altogether unique.

Clay Ironstones occur in many parts of the Nova Scotia coal-field. In the workings of the main seam of the Albion Mines, Pictou, considerable quantities of nodular black ironstone are extracted, and will, no doubt, be utilized. In the beds under the main seam there are also clays rich in ironstone concretions. Beds with ironstone balls also occur in the measures north of the New Glasgow conglomerate, and one of these is remarkable for the fact that the nodules were found by Dr. Harrington to contain nuclei of Blende, a mineral otherwise unknown in the carboniferous of Nova Scotia. No attention has yet been given to these ores as sources of iron, but it may be anticipated that a demand for them will arise in connection with the richer ores in the older formations.

II. Veins of Iron Ore.

(1) *Great Specular Iron Veins of the Silurian Slates and Quartzites.*

In a paper on the metamorphic and metalliferous rocks of Eastern Nova Scotia in 1848,* I mentioned the fact that the inland series of metamorphic rocks (bounding the coast series now known as the gold-bearing series) and believed to be of Upper or Middle Silurian age, abound in veins of specular iron, associated with spathic iron and ferruginous dolomite, and occasionally with metallic sulphides, and I described some of these deposits. In the country eastward of Lochaber Lake, where this same formation occurs, not only are numerous small veins of specular iron and carbonate of iron found in it, but a rich vein of Copper Pyrites, noticed in "Acadian Geology," has recently been opened up and found to be very valuable.

In most parts of the region these iron veins, though very numerous, are of trifling thickness; but in two localities they are known to attain to gigantic dimensions, rendering them of great economic importance.

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* Journal of Geological Society of London.

The earliest known of these was the great vein of the Acadia mine in the Cobequid mountains, discovered by the late Mr. G. Duncan, and on which I reported in 1845. These hills consist on their southern side of parallel bands of olive and black slate with beds of quartzite, all very highly inclined. The iron vein is a great irregular fissure, extending for many miles parallel to the bedding, and apparently accompanying a band of quartzite. It contains in addition to crystalline and often micaceous Specular iron and Magnetic iron, large quantities of a rich earthy red ore, which from the crystalline planes which it presents, would seem to have been a Carbonate of Iron decomposed and oxidised. These iron ores are associated with large quantities of a crystalline ferruginous Dolomite, allied in composition to Ankerite. This may be regarded as the veinstone to which the iron ores are subordinate, and which in the thinner parts of the vein occupies nearly its whole breadth. At the outcrop of the vein it is in some places weathered to a great depth into a soft and very pure yellow ochre. Small quantities of sulphides of iron and copper and of sulphate of barium are occasionally present. In addition to the above, which may be regarded as the primary contents of the vein, there occur in some parts of it secondary deposits of concretionary Limonite, which have of late years afforded a very large part of the ore smelted by the Acadia Company.

In some places the thickness of this vein has been found to be 150 feet, with intercalated masses of rock, but it is very irregular, diminishing occasionally to mere strings of ankerite. It is remarkable that in the Cobequid mountains, which are cut by transverse ravines to the depth of about 300 feet, the vein does not appear to be well developed in the bottoms of the ravines, but only in the intervening heights At first I was disposed to account for this by supposing that the deposit is wedge-shaped, diminishing downward; but I have more recently been inclined to believe that the large development of the vein is dependent on differences in the containing rocks which have rendered them harder and more resisting at the points of such greater developments.

With respect to the age of these beds, they must be older than the Lower Helderberg rocks, which both at the eastern end of the Cobequids and at the East River of Pictou, rest upon them. They are on the other hand probably newer than the auriferous primordial rocks of the Atlantic coast. As they have afforded no fossils their age does not at present seem capable of more precise definition. With regard to the filling of the vein fissures, this, if coeval with the metamorphism of the containing beds or immediately subsequent thereto, would fall between the period of the lower Devonian and that of the lower Carboniferous, or within the Devonian age. The denudation connected with the Lower Carboniferous conglomerates and the fragments contained in these conglomerates, seem to imply that the ore-bearing slates were then in the same condition as at present. On the other hand the Lower Carboniferous sandstones themselves contain in places narrow veins of specular iron, which also occurs, as well as magnetic iron, in the fissures of the Triassic trap.

On the west side of the East River of Pictou, there occur rocks precisely similar to those of the Cobequid range, of which indeed they may be regarded as an Eastern continuation, and including an iron vein which must be regarded as the equivalent of that of the Acadia Mine, which it resembles perfectly in mineral character and mode of occurrence, differing only in the greater proportionate prevalence of the specular ore.*

In New Lairg, a few miles from Glengarry Station, the most western portion of this vein known to me, contains much Ankerite, with strings of Specular iron; and in large loose pieces there are indications also of red ore which is not visible in place. Farther to the eastward on the West Branch of the East River of Pictou, there appears a band of quartzite thirty feet thick filled with veins of Limonite; but specular ore is not found at this place. Still farther to the eastward and near the east branch of the East River the specular vein attains a very large development, shewing in some places a thickness of twenty feet of pure ore. Its course is S. 60° to 70° E. or nearly coincident with that of the containing beds; and as on the Cobequids, its attitude is nearly vertical and it appears to be thickest and richest in the rising grounds. In one very deep ravine the bed of quartzite usually associated with the ore seemed to be wanting, and the vein was represented by innumerable strings of Ankerite, forming a network in the slate. As in the Cobequid vein, masses of Magnetic ore are occasionally mixed with the Specular. To complete the resemblance, loose masses of Limonite are found in the vicinity of the vein, giving rise to the expectation that a vein or veins of this mineral may be found to be associated with the specular ore. The ores of this vein in Pictou County are nearly pure peroxide of iron, containing from 64 to 69 per cent. of metal, and can be obtained in great quantity from the outcrop of the vein where it appears on the rising grounds.

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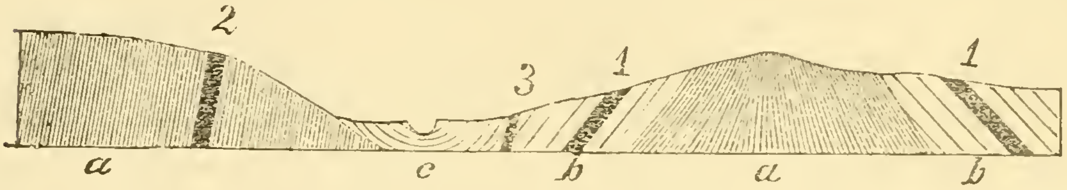
* This vein was first described by the late Mr. Hartley in the Report of the Geological Survey of Canada, 1870.



Ideal Section, showing the general relations of the Iron Ores of the East River of Pictou.

1. Great bed of Red Hematite.
2. Vein of Specular Iron.
3. Vein of Limonite.

(*a*) Older Slate and Quartzite series, with Trap, &c.
(*b*) Lower Helderberg formation and other Upper Silurian rocks.
(*c*) Lower Carboniferous of the East Branch of East River.

(2) *Limonite veins of the East River of Pictou.*

The valley of the East River of Pictou above Springville is occupied by a narrow tongue of Lower Carboniferous rocks, having at one side the slates containing the ore last mentioned, and on the other a more disturbed country already referred to as containing the great Lower Helderberg bed of Hematite. It is highly probable that the river valley follows the line of an old pre-carboniferous line of fracture, denuded and partially filled with the Lower Carboniferous beds, including large deposits of limestone and gypsum. At the line of junction of the Carboniferous and older rocks on the east side of the river, occurs the great Limonite vein of the district, forming a vein of contact of exceeding richness and value. It follows the sinuosities of the margin of the older rocks, and varies in thickness and quality in different places; being apparently richest opposite the softer slates and where these are in contact with a black manganesian limestone, which here, as in many other parts of Nova Scotia, forms one of the lowest members of the Carboniferous series. The ore is sometimes massive but more frequently in fibrous concretionary balls of large size, associated with quantities of smaller concretionary or "gravel" ore. In some places the ore of iron is associated with concretions or crystalline masses of Pyrolusite and Manganite.

Denuding agencies in the Post-pliocene period have removed portions of the vein and its wells, and have deeply covered the surface in many places with debris. Hence the outcrop of the vein was originally marked by a line of masses of the ore too heavy to be removed by water. From the analogy of the other veins to be mentioned in the sequel, I was led to believe that the source of these masses would be found in the Lower Carboniferous rocks, and so stated the matter in the first edition of Acadian Geology (1855). Subsequently, however, the vein having been exposed in situ, and one wall proving to consist of metamorphic slate, it was described by Dr. Honeyman and by Mr. Hartley of the Geological Survey as a vein in the Silurian rocks. Still more recently exploratory works conducted by Mr. G. M. Dawson, with the aid of Mr. D. Fraser, have clearly proved that the vein follows the junction of the two formations. The ore of this vein is of the finest quality, affording from 62 to 65 per cent. of metallic iron. The more productive portions of this vein, as well as of the specular vein in its vicinity, are in the hands of the parties already referred to, in connection with the Hematite bed.

(3) *Limonite of Shubenacadie, Old Barns and Brookfield.*

At the mouth of the Shubenacadie River, the lowest Carboniferous bed seen is a dark-coloured laminated limestone, in all probability the equivalent of the Manganesian limestone already referred to, as well as of the Manganiferous limestone of Walton, the Plumbiferous limestone of the Stewiacke, and the lower black limestone of Plaister Cove, Cape Breton.* This limestone and the sandstones and marls overlying it, are traversed by large fissure veins, holding a confused aggregation of iron ores and other minerals, as Limonite, Hematite, Gothite, Sulphate of Barium, Calcite, &c., some of which appear sufficiently large and rich for profitable exploration. In the same formations, further to the eastward, at Old Barns, similar veins are found to be largely developed, and at Brookfield, fifty miles east of the Shubenacadie, and apparently near the junction of the Lower Carboniferous with older rocks, large surface masses of Limonite appear to indicate an extensive deposit of similar nature, but which has not, I believe, been yet so far opened up as to establish its practical importance.

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* See Acadian Geology.

(4) *Iron Veins of the Triassic Trap.*

Veins of Magnetite and Specular Iron occur in several localities in the great beds of trap associated with the Triassic red sandstones of the Bay of Fundy, but so far as known these ores are insignificant in quantity.

It will be observed from the above notes, that while the iron vein of the Cobequid hills is at no great distance from the coal-field of Cumberland, with which it has now railway connection, the still larger and more important deposits of Pictou are very near to the extensive collieries of that district, and to railway and water communication, so that every facility appears to exist for their profitable exploration, and it may be anticipated that they will soon be rendered available for the supply of iron of superior quality, more especially to meet the large and increasing demand of the Dominion of Canada.

DESCRIPTIONS OF NEW FOSSILS FROM THE DEVONIAN ROCKS OF WESTERN ONTARIO.

By H. Alleyne Nicholson, M.D., D. Sc., M.A., F.R.S.E.,
Professor of Natural History in University College, Toronto.

Having been engaged for some time in studying the fossils of the Corniferous Limestone of Western Ontario, I purpose in the present communication to give brief descriptions of some of the new forms which have come under my notice. I shall, however, simply give the descriptions, without illustrations, as I am preparing a detailed report upon the fossils of some of the Palæozoic formations of Ontario, in which the species in question will be fully illustrated.

I. Zaphrentis fenestrata, n. sp.

Corallum simple, cylindro-conical, curved. Tabulæ well developed, remote, bending downwards as they approach the outer wall. Septa strong, equally developed, not alternately large and small, apparently forty-eight in number. Epitheca thin, with a few shallow undulations of growth, but destitute of vertical striæ or costæ.

This species is closely allied to *Z. gigantea*, Lesueur, but appears to be clearly distinct; though the above description is founded upon but a single specimen, which is all that I have as yet obtained. It differs from *Z. gigantea* in the greater proportionate thickness, and much smaller number of the septa, and in the greater remoteness of the tabulæ. Thus in *Z. gigantea* the septa are from seventy to one hundred and forty in number, and they are alternately small and large; whilst their thickness is not particularly great, and the distance between the tabulæ is not excessive. *Z. fenestrata* is also a smaller form than *Z. gigantea*. From *Z. prolifica*, Billings, the present species is distinguished by its greater size and more cylindrical form, and the much smaller number of the septa, as well as by the fact that the septa are not alternately of different sizes. *Zaphrentis patula* of Edwards and Haime, possesses forty equal septa, but is of a much smaller size, and its shape is much more turbinate. *Z. centralis*, of the same authors, is also very much more diminutive in its dimensions.

The tabulæ of the circumference of the coral in *Z. fenestrata*, where they bend downwards to meet the epitheca, appear to be clearly of the nature of highly developed dissepiments; since they are not placed at exactly the same level in contiguous interseptal loculi. The specific name is in allusion to the peculiar fenestrated appearance exhibited by portions of the coral from which the epitheca has been removed, when the interseptal loculi are seen to be crossed at intervals of from two to three lines by the obliquely descending tabulæ, producing the appearance of a series of oblong fenestrules.

Length of the only specimen observed five inches (real length probably nearly twice as much); diameter of summit one inch and a half. Calice and fosette unknown.

Locality and formation.—Corniferous limestone, Port Colborne.

Genus BLOTHROPHYLLUM (Billings).

" Corallum simple, turbinate or cylindrical. Internal structure consisting of a central area occupied by flat transverse diaphragms, an intermediate area with strong radiating septa, and an outer area in which there is a set of imperfect diaphragms projecting upwards, and bearing on their upper surfaces rudimentary radiating septa. A thin complete epitheca, and a septal fosette." (Billings, Canadian Journ., New Series, Vol. IV., p. 129.)

The central space of the theca is occupied in corals of this genus, as in *Amplexus*, by flat or slightly flexuous tabulæ, upon which the septa encroach slightly or not at all. Outside this central area is a narrow zone in which the tabulæ are bent downwards towards the base of the corallum, and are at the same time occasionally split or bifurcated; whilst the continuity of the spaces between them is interfered with by a series of strong septa. Outside this, again, is an outer zone formed by a series of tabulæ which are directed upwards and outwards in an arching manner, and which carry on their upper surfaces a series of imperfect septa, their lower surfaces being simply costate or ridged. Lastly, the tabulæ of this external zone are walled in by a thin but strong epitheca, with which the outer surface of the coral is invested.

The genus differs from *Zaphrentis* in not having the septa prolonged inwards to, or near to, the centre, and in having the central tabulate area surrounded by an intermediate imperfectly vesicular zone, surrounded in turn by an exterior zone of arched tabulæ and incomplete septa. From *Amplexus* it is distinguished by the possession of the exterior zone last mentioned, and by the septa being more largely developed; whilst it is distinguished from *Clisiophyllum* by the first of the above-mentioned peculiarities, and also by the fact that the tabulæ of the central area are nearly or quite flat, and are not elevated into a conical protuberance.

The genus *Blothrophyllum* was originally defined by Mr. Billings (*op. cit.*), and the single species *B. decorticatum* was described. In addition to this previously recorded and very characteristic species, I have now to describe an allied form, *B. approximatum*, also from the Corniferous limestone of Western Ontario.

II. BLOTHROPHYLLUM APPROXIMATUM, n. sp.

Corallum of unknown length, cylindrical or cylindro-conical. The outer area consisting of strong arched diaphragms, curving upwards and outwards, distant from one another from half a line to two lines, bearing upon their upper surface imperfect septa which extend from one tabula to another when the tabulæ are remote by the former distance only, but which otherwise do not do so. Septa alternately large and small, distant from one another about a third of a line. Tabulæ of the central area closely approximated, from three to four in the space of two lines, flat or slightly flexuous, the septa only slightly encroaching on them. Epitheca with numerous constrictions of growth and encircling annulations, as well as obscure longitudinal striæ. Dimensions unknown, but certainly attaining a diameter of three inches.

In most of its essential characters this species agrees with *B. decorticatum*, Billings, of which perhaps it may turn out to be only a variety. It is, however, distinguished by the apparently constant peculiarity that the tabulæ of the outer area are very closely set, much more closely than in *B. decorticatum*. Thus, typical specimens of the latter exhibit only from three to five of the curved tabulæ of the outer area in the space of an inch; whereas examples of *B. approximatum* present no less than from ten to fourteen tabulæ in the same space. Whether this character is one of specific value or not, may be questioned. but I think it advisable to refer the specimens which exhibit it, provisionally at any rate, to a new species.

Locality and formation.—Corniferous Limestone of Port Colborne.

Genus HELIOPHYLLUM (Hall).

The genus *Heliophyllum* is very closely allied to *Cyathophyllum*, and the following are the definitions of it, given respectively by Milne Edwards and Haime, and by Mr. Billings:

1. “Corallum simple. Septal apparatus well developed, and producing lateral lamellar prolongations, which extend from the wall towards the centre of the visceral chamber, so as to represent ascending arches and to constitute irregular central *tabulæ*, and which are united towards the circumference by means of vertical dissepiments.” (Milne Edwards and Haime.)

2. “Corallum simple or aggregate; radiating septa well developed, obliquely striated on their sides by thin elevated ridges, which extend from the outer wall in an upward curved course towards the centre. These ridges are connected by numerous thin laminæ, which divide the spaces between the septa into small sub-lenticular cells. The transverse diaphragms are thin,

flexuous, and confined to the central portion of the coral." (Billings.)

The internal structure which distinguishes corals of the genus *Heliophyllum* is thus of a somewhat complicated nature. The septa are well developed and extend nearly or quite to the centre of the theca, where they are often somewhat twisted; but there is no columella. A central tabulate area exists, but is of comparatively circumscribed dimensions. Externally to this tabulate area, the interseptal loculi are divided into cells or small compartments by the intersection of two sets of dissepiments having different directions. The dissepiments of the first and most conspicuous set are directed from the internal surface of the wall obliquely inwards and upwards towards the centre, in a succession of arches, the convexities of which are turned upwards. These dissepiments doubtless correspond with that circumferential portion of the tabulæ, which is bent downwards towards the base of the coral in species of *Zaphrentis*, *Clisiophyllum*, *Diphyphyllum*, &c. When these dissepiments are more or less imperfect or have suffered destruction, they leave upon the flat surfaces of the septa a corresponding number of arched striæ or ridges. Similarly, in the calice of the coral these dissepiments appear on the free edges of the septa as so many short spines. The dissepiments of the second series are more delicate, more discontinuous, and much more variable in direction than those of the preceding series. Sometimes they are nearly vertical, or, in other words, are pretty nearly concentric with the theca. Sometimes they are not far from the horizontal, and intersect the dissepiments of the former series at a very acute angle. Most commonly they are directed inwards and downwards from the theca towards the centre, so as to cut the dissepiments of the preceding series nearly at right angles. Decorticated examples of *Heliophyllum* exhibit a most characteristic appearance, due to the intersection of the septa and filled-up interseptal loculi with the dissepiments of the first mentioned series. In this way is produced a succession of vertical ridges and intervening sulci crossed by numerous curved or sharply zig-zagged encircling ridges.

The species of *Heliophyllum* which have been described by Mr. Billings as occurring in the Devonian rocks of Canada, are *H. Eriense*, *H. Cayugaense*, *H. Canadense*, *H. exiguum*, *H. colligatum*, *H. Halli*, and *H. tenuiseptatum*, the first five from the Corniferous formation, and the last two from the Hamilton shales. All these, except *H. tenuiseptatum*, have come under my notice as occurring in the Corniferous Limestone of Western Ontario, and I have also a single new form to record.

III. HELIOPHYLLUM COLBORNENSE, n. sp.

Corallum simple, cylindrical, not expanding towards the cup. Septa sixty at a diameter of one inch, carrying on their flat surfaces arched striæ at distances of from one-third to half a line. Epitheca with numerous rounded or sharp-edged annulations and constrictions of growth. A flat space at the bottom of the cup, to the centre of which the septa extend. Cup deep; fossette unknown.

This species is nearly related to *H. Cayugaense* and *H. Canadense*, Billings; but it is, I think, decidedly distinct. It is distinguished from *H. Canadense* by its cylindrical and not broadly-expanding shape, the cup being equal to or even less than the diameter of the coral at a point apparently a little above the base; by the flattening of the bottom of the calice; by the greater closeness of the arched septal striæ; and by the smaller number of septa. From *H. Cayugaense* the present species is separated by its much smaller thickness, its cylindrical, not expanding form, the smaller number of the septa, and the closeness of the septal striæ.

The length of *H. Colbornense* must have been over three or four inches; but none of my specimens are perfect. The dimensions of a broken individual are: length two inches and a-half; diameter of broken base one inch; diameter of cup ten lines; depth of cup four lines. In another also broken specimen, the length is two inches and a quarter; the diameter at the broken base thirteen lines; the diameter of the cup one inch; and the depth of the cup five lines. Other examples referable to this species exhibit a diameter of from an inch and a quarter to an inch and a half.

Locality and Formation.—Corniferous limestone of Port Colborne.

IV. PETRAIA (?) LOGANI, n. sp.

Corallum small, turbinate, more or less curved, almost trigonal in transverse section, owing to its being flattened on the side of the convex curvature, and also on the lateral surfaces. Septa twenty-six or twenty-eight at a point a little above the base, but sixty or more at the margin of the calice, the increase of number being due to the bifurcation of each primary septum at a distance of about a line and a-half above the base, and also to the intercalation of new septa along both sides of a line which runs along the dorsal or convex side of the coral from top to bottom. This line is marked on the exterior by two primary septa, which form a prominent ridge externally and pass inwards to the centre of the coral. At the margin of the cup the septa are somewhat unequally developed, being alternately larger and smaller, the larger primary septa being prolonged inwards to the centre ot the theca, where they become somewhat bent and twisted together. No columella appears to be present, nor are there any *tabulæ.* The flat sides of the septa are furrowed with a succession of deep grooves, about four or five in the space of one line, which are directed in an obliquely ascending and arching manner from the wall towards the centre, the interspaces between them being tumid and rounded, and thus imparting a crenulated appearance to the outer edges of the septa when exposed to view. These arching grooves are not connected with lamellar dissepiments having a similar direction; but the septa for some little distance below the cup are united by delicate transverse dissepiments. The epitheca is marked with a few annulations of growth, which are mostly very obscure, and with well marked costæ or striæ corresponding with the septa.

In none of the specimens in my possession does the epitheca extend more than half an inch (often less) above the base of the corallum. Beyond this point to the margin of the calice, the edges of the septa are seen with their characteristic crenulated appearance, and united here and there by minute dissepiments. As already noted, the flattened convex side of the coral always exhibits two pre-eminently large septa, produced by the bifurcation of one, which run from the top to the bottom of the coral in a straight line. The remaining septa are directed obliquely from both sides towards this central pair; so that new septa are intercalated along this line in proceeding from the base to the calice. It is possible that these two septa may mark the position of a fosette in the cup; but none of my specimens exhibit the interior of the calice, and I am, therefore, unable to speak positively on this point. For the same reason I can say nothing as to the condition of the free edges of the septa internally.

The total length of the corallum is from three-quarters of an inch to one inch, the diameter of the calice varying from half an inch to nearly three-quarters. The calice is oblique, so that the greatest length of the coral is along its convex curvature.

Petraia Logani is closely allied to *Petraia* (*Turbinolopsis*) *pluriradialis*, Phillips, with which I was at first sight disposed to identify it. It is, however, readily distinguished by the flattening of the convex curvature and lateral aspects of the coral, and by the smaller number of radiating septa. As regards other more minute characters, the published descriptions of *P. pluriradialis* are not sufficient to enable any closer comparison to be instituted with advantage between the two species.

There exists also a singular, and in some respects inexplicable, resemblance between the form here described under the name of *P. Logani*, and that described by Mr. Billings under the name of *Heliophyllum exiguum* (Can. Journ. New Series, Vol. V. p. 261); at the same time that differences of such gravity exist that the two forms cannot be united under the same specific title, or even placed in the same genus. Without pretending at present to explain the discrepancies of observation here alluded to, it may be as well to present in a summary form the points of agreement and difference which appear to exist between the two species.

1. Both corals are of the same general form and size, and occur not only in the same formation, but also at the same locality.

2. Both corals are alleged to possess externally a couple of straight septal ridges, extending from the top to the bottom of the coral, and having the other septa directed obliquely towards this line on both sides. I have, however, never been able to detect this structure in the comparatively few specimens which have come under my notice, which I should feel disposed to refer to *H. exiguum*.

3. The number of septa in the cup appears to be about the same in both, though said to be sometimes as many as eighty in *H. exiguum*, whilst they never appear to exceed sixty-five in *P. Logani*.

Whilst the above are the chief points of agreement, there are the following points of difference to be noted:

1. *H. exiguum*, though this is not specially alluded to, must possess more or less well developed *tabulæ*; but no traces of such structures can be detected in *P. Logani*, in broken specimens or in longitudinal sections.

2. The septa in *H. exiguum* exhibit on their flat sides "about six obscure arched *striæ* to one line." Those of *P. Logani* exhibit a succession of arched *grooves* of considerable depth, separated by somewhat tumid interspaces; and these grooves are only about four or five in the space of one line. Nor can it be supposed that this discrepancy is due to any confusion on my part between *casts* of *P. Logani* and the actual coral itself, such a mistake being impossible in dealing with the well-preserved specimens of the Corniferous formation.

3. The septa in *P. Logani* bifurcate regularly in proceeding from the base to the cup, thus being always arranged in pairs in the upper part of the coral; whilst no such arrangement is stated as regards *H. exiguum.*

4. When looked at as seen in transverse sections of the cup, the septa of *H. exiguum* are seen to possess plain sides, as is the case in *Zaphrentis;* whilst those of *P. Logani* are denticulated with tooth-like dissepiments or spines, which rarely extend to the contiguous septum. It need hardly be said that the structures here alluded to are not to be confounded with the spines which occur on the *free edges* of the septa of *H. exiguum*, as in the genus *Heliophyllum* in general.

5. The epitheca of *H. exiguum* is thick, deeply annulated, hardly showing the lines of the septa, and co-extensive with the outer surface of the coral. In *P. Logani*, on the other hand, the epitheca is very slightly marked with ridges of growth, usually exhibits distinct costæ, and never appears to extend to the margin of the calice; though it is certainly difficult to say positively whether this last appearance is natural or is due to a partial decortication of the coral.

Upon the whole, I think that the fossil here described as *Petraia Logani* is distinct from previously known forms. Its reference to *Petraia* is provisional, but it apparently cannot be referred under any circumstances to the genus *Heliophyllum*. I have named it in honour of the eminent geologist, Sir William Logan, F.R.S.

Locality and formation.—Not uncommon in the Corniferous Limestone of Rama's Farm, Port Colborne.

V. Alecto (?) Canadensis, n. sp.

Polyzoary adnate, attached parasitically to the exterior of corals, branching in an irregularly dichotomous manner. Cells in reality uniserial, but so disposed by the turning of each cell-mouth to alternate sides as to look as if bi-serial. The terminal portion of each cell bent outwards; the aperture circular. The cells tubular, elongated, slightly or not at all expanded and not at all elevated towards their apertures. Five cells in the space of two lines; width of cell about one-fiftieth of an inch near the mouth.

I have considerable doubts as to the affinities of this extraordinary little fossil; but I think it is certainly one of the Cyclostomatous Polyzoa, and I see at present no better course than to refer it to *Alecto*, Lamoroux. When not examined closely, the fossil presents a striking resemblance to a Sertularian Zoophyte, exhibiting exactly the appearance of a number of tubular calycles or cells springing alternately from the two sides of a common canal or stem. When minutely looked into, however, it is seen that this is deceptive, and that the fossil consists really of an alternate or sub-alternate series of long, tubular, slightly flexuous cellules, each cell being nearly cylindrical, and having the terminal portion geniculated or bent outwards, in such a manner that the mouths of successive cells point in opposite directions.

The difficulty in determining the systematic place of this fossil is much increased by the fact that it occurs solely in the form of casts, ramifying in the walls of moulds from which corals have been removed. It is, therefore, impossible to determine what was the texture of the cœnœcium, whether calcareous or corneous; whilst the lines of division between the cells, where they come in contact with one another, are only very faintly and obscurely indicated. The form of the aperture of the cell appears to have been circular, and its position terminal; but some uncertainty attaches to both of these statements.

Locality and Formation.—Common, growing parasitically upon the corallites of *Diphyphyllum arundinaceum*, or upon the epitheca of *Fistulipora Canadensis*, in the former position generally accompanied by a species of *Spirorbis*. Corniferous Limestone, Port Colborne, and Lot 6, Con. 3, Wainfleet.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

At the recent meeting of the American Association held at Portland, a large number of interesting papers were read, one of which, by Principal Dawson, is given in full in the present number of this journal.

We have, as yet, been unable to obtain full reports of the proceedings; but give a few abstracts of some of the most interesting papers and discussions, from the reports of the *New York Tribune.*

ADDRESS OF THE PRESIDENT.

The address of J. Lawrence Smith, the retiring President, was read by Prof. Putnam, the President being absent in Vienna. The following is given by the *Tribune* as the most significant portion:

It is not my object to criticise the speculations of any one or more of the modern scientists who have carried their investigations into the world of the imagination; in fact, it could not be done in a discourse so limited as this, and one only intended as a prologue to the present meeting. But in order to illustrate this subject of method more fully I will refer to Darwin, whose name has become synonymous with progressive development and natural selection, which we had thought had died out with Lamarck 50 years ago. In Darwin we have one of those philosophers whose great knowledge of animal and vegetable life is only transcended by his imagination. In fact, he is to be regarded more as a metaphysician with a highly wrought imagination than as a scientist, although a man having a most wonderful knowledge of the facts of natural history. In England and America we find scientific men of the profoundest intellects differing completely in regard to his logic, analogies, and deductions; and in Germany and France the same thing—in the former of these countries some speculators saying "that his theory is our starting-point," and in France many of her best scientific men not ranking the labors of Darwin with those of pure science. Darwin takes up the law of life and runs it into progressive development. In doing this he seems to me to increase the embarrassment which surrounds us on looking into the mysteries of creation. He is not satisfied to leave the laws of life where he finds them, or to pursue their study by logical and inductive reasoning. His method of reasoning will not allow him to remain at rest; he must be moving onward in his unification of the universe. He started with the lower order of animals, and brought them through their various stages of progressive development until he supposed he had touched the confines of man; he then seems to have recoiled, and hesitated to pass the boundary which separated man from the lower order of animals; but he saw that all his previous logic was bad if he stopped there, so man was made from the ape (with which no one can find fault, if the descent be legitimate). This stubborn logic pushes him still further, and he must find some connecting link between that most remarkable property of the human face called expression; so his ingenuity has given us a very curious and readable treatise on that subject. Yet still another step must be taken in this linking together man and the lower order of animals: it is in connection with language; and before long it is not unreasonable to expect another production from that most wonderful and ingenious intellect on the connection between the language of man and the brute creation.

Let us see for a moment what this reasoning from analogy would lead us to. The chemist has as much right to revel in the imaginary formation of sodium from potassium, or iodine and bromine from chlorine, by a process of development, and call it science, as for the naturalist to revel in many of his wild speculations, or for the physicist who studies the stellar space to imagine it permeated by mind as well as light—mind such as has formed the poet, the statesman, or the philosopher. Yet any chemist who would quit his method of investigation, of marking every foot of his advance by some indelible imprint, and go back to the speculations of Albertus Magnus, Roger Bacon, and other alchemists of former ages, would soon be dropped from the list of chemists and ranked with dreamers and speculators.

What I have said is, in my humble opinion, warranted by the departure Darwin and others have made from true science in their purely speculative studies; and neither he nor any other searcher after truth expects to hazard great and startling opinions without at the same time courting and desiring criticism; yet dissension from his views in no way proves him wrong—it only shows how his ideas impress the minds of other men. And just here let me contrast the daring of Darwin with the position assumed by one of the great French naturalists of the present day, Prof. Quatrefages, in a recent discourse of his on the physical character of the human race. In referring to the question of the first origin of man, he says distinctly, that in his opinion it is one that belongs not to science; these questions are treated by theologians and philosophers: "Neither here nor at the Museum am I, nor do I wish to be, either a theologian or a philosopher. I am simply a man of science; and it is in the name of comparative physiology, of botanical and zoölogical geography, of geology and palæontology, in the name of the laws which govern man as well as animals and plants, that I have always spoken." And studying man as a scientist, he goes on to say: "It is established that man has two grand faculties of which we find not even a trace among animals. He alone has the moral sentiment of good and evil; he alone believes in a future existence succeeding this natural life; he alone believes in beings superior to himself, that he has never seen, and that are capable of influencing his life for good or evil; in other words, man alone is endowed with morality and religion." Our own distinguished naturalist and associate, Prof. Agassiz, reverts to this theory of evolution in the same positive manner, and with such earnestness and warmth as to call forth severe editorial criticisms, and by his speaking of it as a "mere mine of assertions," and "the danger of stretching inferences from a few observations to a wide field;" and he is called upon to collect "real observations to disprove the evolution hypothesis." I would here remark, in defence of my distinguished friend, that scientific investigation will assume a curious phase when its votaries are required to occupy time in looking up facts, and seriously attempting to disprove any and every hypothesis based upon proof, some of it not even rising to the dignity of circumstantial evidence.

I now come to the last point to which I wish to call the attention of the members of the Association in the pursuit of their investigations, and the speculations that these give rise to in their minds. Reference has already been made to the tendency of quitting the physical to revel in the metaphysical, which, however, is not peculiar to this age, for it belonged as well to the times of Plato and Aristotle as it does to ours. More special reference will be made here to the proclivity of the present epoch among philosophers and theologians to be parading science and religion side by side, talking of reconciling science and religion, as if they had ever been unreconciled. Scientists and theologians may have quarreled, but never science and religion. At dinners they are toasted in the same breath, and calls made on clergymen to respond, who, for fear of giving offense, or lacking the fire and firmness of St. Paul, utter a vast amount of platitudes about the beauty of science and the truth of religion, trembling in their shoes all the time, fearing that science falsely so-called may take away their professional calling, instead of uttering in a voice of thunder, like the Boanerges of the gospel, that "the world by wisdom knew not God." And it never will. Our religion is made so plain by the light of faith that the wayfaring man, though a fool, cannot err therein.

No, gentlemen; I firmly believe that there is less connection between science and religion than there is between jurisprudence and astronomy, and the sooner this is understood the better it will be for both. Religion is based upon revelations as given to us in a book, the contents of which are never changed, and of which there have been no revised or corrected editions since it was first given, except so far as man has interpolated; a book more or less perfectly understood by mankind, but clear and unequivocal in all essential points concerning the relation of man to his Creator; a book that affords practical directions, but no theory; a book of facts and not of arguments; a book that has been damaged more by theologians than by all the Pantheists and Atheists that have ever lived and turned their invectives against it—and no one source of mischief on the part of theologians is greater than that of admitting the profound mystery of many parts of it, and almost in the next breath attempting some sort of explanation of these mysteries. The book is just what Richard Whatley says it is, viz.: "Not the philosophy of the human mind, nor yet the philosophy of the divine nature in itself, but, (that which is properly religion) the relation and connection of the two beings—what God is to us, what He has done and will do for us, and what we are to be in regard to Him." * * * Let us stick to science, pure, unadulterated science, and leave to religion things which pertain to it; for science and religion are like two mighty rivers flowing toward the same ocean, and before reaching it they will meet and mingle their pure streams, and flow together into that vast ocean of truth which encircles the throne of the great Author of all truth, whether pertaining to science or to religion. And I will here in defence of science assert that there is a greater proportion of its votaries who now revere and honor religion in its broadest sense, as understood by the Christain world, than that of any other of the learned secular pursuits.

THE EVOLUTION THEORY.

This subject elicited a somewhat lengthy discussion, in which Principal Dawson, Prof. Morse, Prof. Swallow and Prof. Gill took part. The following is the substance of Principal Dawson's and Prof. Morse's remarks:

Dr. Dawson began by stating with some fullness of detail the demands upon our credence made by the advocates of the evolution theory. Among other requirements of the theory, he said it must provide an explanation of the origin of life. To accomplish this the experiments of Bastian were brought forward. Referring to these, he stated that no less an authority than Prof. Huxley, though an evolutionist, had denied their conclusive character and disputed the alleged results. We are expected to admit, in every department to which scientific inquiry relates, that in all things there has been a successive progress from the lower to the higher. Why should we make this admission? What proof is there of it? The recent discoveries of embryology, showing the likeness of early forms of the embryo to other animals of the same families, furnished to the advocates of evolution no real argument in its favor. They proved nothing. Admit, if you will, the close resemblance of similar bones and general physical structure in the ape and man, it is not the slightest evidence of identity. While it may be true that there is bone for bone in monkey and in man, still it remains that the bones of one are different from those of the other. The making of monkey and of man is explicable quite as readily, to say the least, on the theory of plan as on that of evolution. The history of the growth of an animal has been cited as the evidence of a development from a lower to a higher form. But what are the facts in the case? The egg grows into the animal, and that organism produces an egg again. This is revolution, not evolution.

We are told to accept as a postulate that mind too is the result of development; that the moral as well as the material being is simply a consequence of the evolving process. I do not grudge the naturalists who have adopted such theories the intellectual exercise which is involved, but I regret that much of their labor is wasted, and the results will be burnt when the fires of truth are applied to the chaff they are accumulating. This is not a question of physics that they are arguing, it is one of metaphysics, and it would be well for our children, as well as growing scientists, if they were taught more of mental and moral philosophy as a basis for such inquiry. But I thank the students who are thus engaged for some good results of their exertions. They have thereby succeeded in reducing the superfluous numbers of species, and have obtained far better views in respect to classification.

Good results will also flow from the profound embryological researches of the day. But I am sorry for the investigators, for their reputations are at stake, and they have chosen a mistaken path.

We are, however, approaching in our studies a correct theory. After its appearance in geological history, every species has a plastic tendency to spread to its utmost limits of form. Then ensues a period of decadence until it may become extinct. This has been set forth in some of my printed memoirs on the plants of the carboniferous series. I believe that a similar process is true of the human race. He referred to the skull of Mentone and its finely developed character—a grandly developed man cerebrally and bodily. The burial of his dead testified to his religious belief. The people of the Cromagno skull age were of a similarly elevated character. The only point of difference from men to-day was in the flattening of one of the leg bones This was perhaps a result of the habits of the tribe, running through forests in pursuit of game. It begins to be admitted that the man of Western Europe came in with the modern mammalia at the close of the glacial period. This was a period of decadence, and when the pliocene fauna were dying out and new forms were taking their places. The most ancient form of man is beyond the average standard of modern humanity. If the man of Cromagno or Mentone had been sent to Harvard, he would have been graduated with the full honors of an average American student.

Professor Morse rose and stated that the forty minutes allowed for this discussion would scarcely leave time to touch its salient points. It was a question whose bearings might consume a week in their consideration. But a few things might be said. Dr. Dawson and Professor Swallow had both misquoted Huxley, who had said, in respect to the ancient skull referred to, that it might have held the brains of a thoughtless savage, or it might have contained those of a philosopher. Dr. Dawson had referred to only the differences in those remains from those of to day in respect to the flattened tibia. There were, however, several other characters of a similar nature which Dr. Dawson had not referred to, some of which had been discovered by Prof. Wyman, and had not yet been published. In the existing races of man the *foramen magnum* (the large opening at the base of the skull through which the brain communicates with the spinal cord) exhibited very little change of position in its relation to the rest of the skull, while with the higher primates (apes) this opening is very near the posterior portion of the skull. This was illustrated by a rapid drawing on the blackboard. In eleven ancient skulls from the shell heaps of Tennessee, the *foramen magnum* in every case was nearly an inch further back than in those of present existing races. The powerful muscles on the sides of the head that move the jaws leave a distinct line at their upper points of attachment. These lines are called temporal ridges. In all present existing races a space occurs on the top of the skull, between these lines, of from three and a half to four inches. In the apes these muscles meet in the median line which rises into a bony crest so characteristic of the gorilla. There was a remarkable skull discovered by Prof. Wyman in the lowest beds of the ancient shell heaps of Florida. This has the temporal ridges approaching each other within a half inch at the top of the skull. If the high development of the skull referred to by Mr. Dawson was such as he states, it only carries man further back. Similarly in the light thrown upon the history of man by the wonderful discoveries in archæology, where we meet with traces of an ancient civilization, with complicated language and manners, we can surely believe in savage hordes pre-existing from which this ancient civilization has been evolved.

As to the early traces of man we must fully appreciate the rare possibility of their occurrence. Wherever you dredge in the waters of the present day the traces of man are among the rarest discoveries. The Lake of Haarlem, upon whose waters naval battles have been fought, and on whose shores a dense population has existed, was drained, and on its bottom not the slightest traces of man's existence were found. Prof. Morse dredged repeatedly for years off the shores of Maine, and no trace of man was ever brought up, except a single spike. When we consider how abundant the material for such remains must be now compared with those furnished by the simple methods of life and the sparse population of earlier days, the indications of man's existence in geological èras must be of the rarest occurrence. In fact, in such rocks as the drift, only the rude stone implements could be preserved.

Alluding to the brief moments left for the debate, Prof. Morse said there was but time to say that the evolution theory, as compared with that of special creation, presented similar features to the undulatory theory of light as compared with the emission theory. Newton's theory required a new modification with every discovery in optics, until, as a writer said at that time, the emission theory is a mob of hypotheses. The undulatory theory of Young not only explained all that was dificult to Newton, but gave physicists the power of prevision. So with evolution; it not only accounts for existing phenomena from the modification of a flower or the spot on a butterfly's wing to the genesis of the solar system, but it has endowed naturalists with the gift of prophecy and enabled them to predict the intermediate forms afterwards discovered in the records of the rocks.

CALVERT'S SUPPOSED RELICS OF MAN IN THE MIOCENE OF THE DARDANELLES.

By George Washburn, Hobart College.

Sir John Lubbock announced not long ago that Mr. Calvert had discovered evidence at the Dardanelles of the existence of man in the Miocene period. He reported that 800 feet below the surface flint instruments had been found; also, bones split lengthwise, but especially a fossil bone upon which had been engraved a picture of a horned animal. The author, in company with Mr. Forbes, Instructor in Mathematics in Hobart College, visited the spot last April, and found Mr. Calvert engaged in mining and ready to aid them. The deposits were found midway between the Dardanelles and the plains of Troy. The hills rise abruptly about 800 feet above the Straits, and are cut by deep ravines which exhibit the formation.

The lowest formation exposed at this point is an argillaceous limestone nearly white, containing no fossils, of irregular thickness, and smooth, like pressed clay, on its upper surface. Above this are irregular beds of earth and clay of different colors; next is a deposit of white sea-sand 500 feet thick, which contains, at irregular intervals, pebble beds from one to four feet thick; next is a bed of shell limestone at least 100 feet thick. These shells are of the brackish water variety. Tchinatheff, in his "Asia Minor," calls this Miocene. The fossils and flints were closely examined, and the investigators arrived at the conclusion that they were shaped by the action of water. Teeth of the mastodon and parts of tusks were found. The bones found were in so small fragments that it was not possible to determine them. Similar fragments of flint, exhibiting no other action than that of water, were found in abundance in the pebble formation near Dardanelles, and it was only a question of selecting from piles of stones those that happened to take a certain shape.

Mr. Calvert has in his collection several bones split lengthwise, with the marrow gone. This cannot be denied. But it is to be doubted if such bones proved the existence of human beings. They found in the hole of a jackal, on the plain of Troy, sheep bones which had also been split lengthwise, and they inferred that if the bones were split they were the work of beasts. But it is very doubtful if the bones found were broken in this way; for they found that when one of the whole bones was dropped it broke lengthwise, and as all the marrow was gone, it resembled the split bones.

The bone with the supposed engraving is a fragment about eight inches in diameter, shaped like a flattened sphere, one surface smooth, the other rough. It has been called the bone of a Mastodon or of a Dinotherium, but is so small that it cannot be determined. Mr. Calvert has had it about 20 years, but only lately, since he read Sir John Lubbock's book on bones in France, has he distinguished the engraving upon it. The smooth surface has some 50 marks, more than half which are grouped in the centre. Taken individually, they are peculiar and puzzling, but taken together, they can hardly represent a sketch of an animal, or show an evidence of design. They were unable to account in a satisfactory manner for the marks, but suggested they might have been produced by worms when the bone was soft. They found the smooth upper surface of the underlying stratum of limestone was covered with exactly similar marks, many groups of which made more striking pictures than those found on the bone. One specimen is so marked that a vivid imagination can distinguish the picture of a wild boar with a spear in his side, with the Greek letter Π most clearly cut by the side of it. No one would dream of attributing all the marks upon the rocks to design, and he thought it equally unreasonable to so attribute the similar marks upon the bone to human agency.

The author reports, therefore, in view of the facts mentioned above as to the flints, the split bones, and the marks upon the fossil bone, that they believe that Mr. Calvert and Sir John Lubbock (who had never seen the specimens) are mistaken in the conclusions to which they have come, and that they have not been able to find any evidence whatever at the Dardanelles in reference to the antiquity of man.

ON THE RELATIONS OF THE NIAGARA AND LOWER HELDERBERG GROUPS OF ROCKS AND THEIR GEOGRAPHICAL DISTRIBUTION IN THE UNITED STATES AND CANADA.

By Prof. James Hall.

The speaker, before proceeding to the discussion of the subject, cited a paper read by Mr. A. H. Worthen at the Troy meeting of the Association, entitled, "Remarks on the relative age of the Niagara and the so-called Lower Helderberg Groups," in which that writer proposed to drop the name of the latter group on the ground of its equivalence with the Niagara. The results of careful field investigation, and the study of the fossils over wide areas for 30 years, it undertakes to set aside, without offering the evidence of any new investigations, or of arguments which could be admitted as proof. Coming from a gentleman holding the position of State Geologist of Illinois, the matter was worthy of the careful attention of the Association. The speaker stated that this view was not original with Mr. Worthen, but was the prevalent opinion among geologists previous to the last 30 years, citing Prof. H. D. Rogers and other authors, giving some details in regard to the causes of the misunderstanding of the geological structure of the country. Here, upon a map of the United States, the colored belts which indicated the formations referred to, he first traced the Niagara group from its typical locality at Niagara Falls, where the formation of shale and limestone has a thickness of over 200 feet, to the eastern portion of the State, where from gradual thinning it sometimes has a thickness of not more than 8 feet, and is known as the coralline limestone. The rock was nevertheless marked by the characteristic fossils, and its place in the series clearly preserved. Returning to the Niagara river, the speaker traced upon the map the course of the Niagara group through Ontario to Cabot's Head, thence by the islands of Lake Huron and the peninsula between Green Bay and Lake Michigan, and thence along the west shore of that lake to its southern extremity; from this point the formation extends in a westerly and north-westerly direction through Illinois and Wisconsin, and thence into Iowa.

Returning thence to the western end of Lake Erie, the Niagara formation was found composing some islands, and extending south-westerly into the State of Ohio and into Kentucky. Over all this area the formation is well defined, and no one had questioned its character. The same formation was also known in Southern Illinois and Missouri, and likewise in Tennessee, where its integrity has been called in question. In Illinois and Tennessee it was claimed that the fossils of the Niagara formation are mingled with those of the Lower Helderberg group. He then proceeded to speak of the rocks of this group as known in its best developments in the Helderberg Mountains and on the banks of the Schoharie and Cobles Kil. The members of the formation are the Tentacalite limestone, the Lower Pentamerus limestone, the shaly limestone, and the Upper Pentamerus limestone, these together constituting a group quite unlike the Niagara group, while of the hundreds of fossils which they contain none are identical with those of the Niagara. These beds in the Schoharie Valley lie above the coralline limestone, which has been shown to be a continuation of the Niagara formation and to be separated from that by a distinct formation known as the water-lime.

On tracing this Lower Helderberg formation on the map, it was shown to thin out in its westerly extension until it was recognized only as a simple band of limestone without fossils. Here, returning to the Helderberg Mountains, the formation could be traced to the Hudson River Valley, and along this valley to the southern part of the State, thence through New-Jersey, Pennsylvania, Maryland, Virginia, and thence into Tennessee. Throughout the greater part of this extent the formation is underlaid by the water-lime formation, and the purity and identity of the formation has not been questioned. Looking to the north-east, the formation is known as lying unconformably over lower rocks, and it had been traced as far as Gaspe on the St. Lawrence, and was known in Maine and New Brunswick. The formation could be traced from the 43rd parallel to the 35th parallel, and this extent, taken in connection with the exposures from the erosion of anticlinals where the rocks are folded, will give us more than 2,000 miles of outcrop where the rocks were characterized by fossils, often in great numbers, and where the mingling with other fossils was unknown. After having thus hastily sketched the ground occupied by these groups of strata, the speaker went on to consider their relations to each other, showing sections at different points from the Schoharie Valley to Central New York, and by a diagram tracing the lines of outcrop and comparative thickness of the several formations over this area. Then calling attention to the asserted mingling of the fossils of the two groups in Illinois and Tennessee, as claimed by Mr. Worthen, he asserted that from his own experience on the Mississippi River no such mingling of fossils is known, except in the debris of the formation; that the Niagara formation, greatly thinned out, lies below the beds of the lower Helderberg beds, and the fossils are quite distinct. In Tennessee, Safford has shown that the formations are quite distinct, each characterized by its own fossils. It was true that Safford had said that along the line of junction the fossils were sometimes mingled; but, in the speaker's mind, the fact did not prove them cotemporaneous; for the Lower Helderberg beds with their living shells and other fossils might have been deposited directly upon the dead fauna of the preceding groups, and thus an apparent mingling produced. That these formations were nowhere cotemporaneous was proved by the great thickness of intervening beds in New York and Canada, where sometimes these intervening rocks were over 1,000 feet thick. He concluded by saying that in reversing the facts and considering the known range and extent of the Niagara and Lower Helderberg groups, their close approximation of actual contact over large areas, and their wide separation elsewhere, there are no two groups of similar composition in the entire palæozoic series so clearly distinct and so unmistakably traceable in their physical and lithological character, as well as in their contained fossils.

BREAKS IN THE AMERICAN PALÆOZOIC SERIES.

By Prof. T. Sterry Hunt.

The author began by considerations on the value and significance of breaks in the succession of strata and of organic remains; he then referred to the classification of the palæozoic rocks of the New York series, and showed that Hall in 1842, and again in 1847, pointed out the existence therein of a fauna older than what was then called Silurian by Murchison, or was known in Great Britain, maintaining that our comparison with British rocks must commence with the Trenton limestone, the equivalent of the Llandeilo or Upper Cambrian of Sedgwick (Lower Silurian of Murchison). The rocks below this horizon in America were the equivalent of the Lower Cambrian of Sedgwick, which, when they were found to be fossiliferous were wrongly claimed by Murchison as part of the Silurian. He sketched the history of the introduction of the nomenclature of Murchison into our American geology, and then proceeded to show the existence of a break both stratigraphical and palæontological at the base of the Trenton. The contact between the calciferous sandrock and the unconformably overlying Trenton is seen in Herkimer County, N.Y., according to Hall. The so-called fossiliferous Quebec group of Logan, the primal and auroral of Rogers, which extends along the great Appalachian valley from the Lower St. Lawrence to Georgia, corresponds to the Lower Cambrian, and the Potsdam Calciferous and Chazy formations are its equivalents in the valley of the Ottawa and Lake Champlain much reduced in thickness. These are overlaid by the rocks of the Trenton and Hudson River groups (Upper Cambrian) which in various localities to the north overlap the older fossiliferous rocks, and repose on the crystalline rocks, indicating a considerable continental movement corresponding to the break in palæontological succession. The relation between these is explained by Logan as resulting from a movement posterior to the deposition of the Hudson River group, which produced a great uplift of several thousand feet, extending for more than 1,000 miles. While showing that there have been movements in parts of the region since that period, the author rejects the explanation, and shows that the relation between the two is due to the fact that the Trenton and the Hudson River rocks overlie unconformably the disturbed Quebec group or Lower Cambrian. These two great series correspond to the rocks of the first and second faunas of Barrande. The second great break is at the summit of the Hudson River group, and is marked by the Oneida conglomerate in New York, and a similar one in Ohio, described by Newberry, The rocks above, to the base of the Corniferous limestone in the New York series, are the Upper Silurian of Murchison, or Silurian proper, and hold what is called by Barrande the third fauna. As long since shown by Hall they are, however, to be divided on palæontological grounds into two groups, the lower including the Medina, Clinton, and Niagara formations, and the upper what was named the Lower Helderberg group. These are separated in New-York and Ontario by the great non-fossilliferous Onondaga group, holding salt and gypsum, and deposited from a great mediterranean salt lake. The close of the Onondaga was marked by another period of disturbance which, like that preceding the deposition of the Trenton, changed the levels and caused the ocean waters to spread alike over the Onondaga formation and the adjacent rocks, which had formed the ancient sea barrier. Then were deposited the Lower Helderberg limestones, followed by the Oriskany sandstone, together constituting a fourth natural division of our palæozoic rocks. These strata were deposited unconformably over the Trenton and Hudson River rocks, in the St. Lawrence valley, and in various localities among the Appalachian hills in New England and the British Provinces. Over this whole region there are no known representatives of the second, and, except to the far eastward, none of the third, or Medina-Niagara fauna. The fourth or highest Silurian fauna corresponds to the Ludlow rocks of Britain, or Upper Silurian of the Canada Survey; while for the third fauna they have applied the name of Middle Silurian. The necessity for such a division in accordance with the views of Hall is admitted, but the name is to be rejected, since the rocks immediately below it are properly not Lower Silurian but Upper Cambrian. Evidence of a fourth break between the Oriskany and the Corniferous were mentioned, in the erosion of the former in New-York and Ontario, although to the eastward in Gaspé, they form a continuous series. The author closed by a tribute to the memory of the venerable Sedgwick, the Nestor of British geologists, who died last Winter, and to the labours of Prof. Hall, who, in his vast work on our palæozoic geology, has reared to himself an imperishable monument.

THE METAMORPHISM OF ROCKS.

By Prof. T. Sterry Hunt.

The various changes which rocks undergo under the influence of water, air, and various gases, and their changes in molecular structure, were briefly noticed, and the use of the name of metamorphic rocks, as now generally applied to crystalline strata, considered. While some geologists had supposed that many of these, such as gneisses, green-stones, serpentines, talcose, and chloritic rocks were igenous products, more or less modified by subsequent chemical precesses, others maintained that they were formed by aqueous sedimentation, and subsequently crystallized. This was taught by Hutton, and when, early in this century, the crystalline rocks of the Alps were shown to rest upon uncrystalline fossiliferous strata, it was suggested that the overlying crystallines were newer rocks, which had undergone a metamorphism from which those directly beneath had been exempted. This notion spread until the great crystalline centre of the Alps was considered to be in part of secondary and even of tertiary age. The history of the extension of this notion to Germany, to the British Islands, and to New England, was then sketched, and it was shown that similar crystalline rocks from supposed stratigraphical evidence came to be referred to formations of very different ages in palæozoic or more recent geologic time. The author then detailed the course of study by which he had been led to question this notion; he showed that there was, according to Faure, no longer any evidence in the Alps in support of the view above noticed, that Sedgwick in England and Nicoll in Scotland had rejected the views of the palæozoic age of the crystalline schists regarded by Murchison as Cambrian and Silurian; and finally gave the observations by which he (the speaker) had satisfied himself that the crystalline rocks of the Green Mountains and the White Mountains, and their representatives alike in Quebec, New Brunswick, and in the Blue Ridge, were more ancient than the oldest Cambrian or primordial fossiliferous strata. He showed how folding, inversion, and faults had alike, in the Alps and in Scotland, led to the notion that these crystalline rocks were in many cases newer than the adjacent fossiliferous strata, and mentioned that the subject would be further illustrated by a paper on the geology of New Brunswick.

ON STAUROLITE CRYSTALS AND GREEN MOUNTAIN GNEISSES OF SILURIAN AGE.

By Professor J. D. Dana.

Prof. Dana has already published the fact alluded to by Percival, that crystals of staurolite are found in mica schist at Salisbury, Conn., underlying directly the Stockbridge limestone. Since then he has found them in Southern Canaan, and at a locality west of Housatonic River, but in this case the schist overlies the limestone. This staurolite also contains garnets. The Stockbridge limestone is admitted to be Lower Silurian. Prof. Dana is sure that the Canaan limestone is identical with that of Stockbridge. In any case there is no reason to doubt that the staurolites occur in the later part of the Lower Silurian age, and strong reason for believing that these schists are in age veritable Hudson River rocks. On this view the Hudson River or Cincinnati group in the Green Mountains—alike in Connecticut, Massachusetts, and Vermont—includes beds of quartzite, mica schist, cholritic mica slate, hydro-mica or talcose slate, well characterized gneiss and granitoid gneiss.

The order of these deposits at South Canaan, Tyringham, and Great Barrington was then given, and the following conclusion reached: The fact that quartzite, limestone and gneiss, or mica schist, here alternate with one another, is beyond question; and if I am right in the age of the deposits as above suggested, the alternations occur at the junction of the Trenton and Hudson River formations. Other particulars respecting the geology of the region referred to were given in Prof. Dana's paper, and the conclusions reached that all old-looking Green Mountain gneisses are not pre-silurian; and further, that the presence of staurolite is no evidence of pre-silurian age.

ON CIRCLES OF DEPOSITION IN SEDIMENTARY STRATA.

By Prof. J. S. Newberry of Columbia College, New York.

The different strata which compose the geological column have been divided into several groups, or systems, of which the base is formed by the old crystalline rocks called Laurentian and Huronian. On these rest the Lower Silurian System, composed of the Potsdam sandstone, the Calciferous sandrock, the Trenton group of limestones, and the Hudson group; the latter forming the summit of the Lower Silurian System. The Upper Silurian System has at its base the Medina sandstone; above this lie in succession the Clinton, the Niagara, and the Helderberg groups.

The Devonian system consists, in like manner, of the Oriskany sandstone, the Schoharie grit, the Corniferous limestone, and the Hamilton group. The carboniferous system, as Prof. Newberry claims, should begin with the Portage and Chemung, above which are the Waverley, the Carboniferous Limestone, and the Coal Measures. Now, if we compare these systems we shall see that they consist of circles of deposition, first, sandstone, viz., the Potsdam, the Medina, the Oriskany, and the Portage; second mixed, mechanical, and organic sediments, viz., the Calciferous, the Clinton, the Schoharie and the Waverley.

The third member of each group is a limestone, viz., the Trenton, the Niagara, the Corniferous and the Carboniferous limestone. The fourth member of each group is a mixture of mechanical and organic sediments, viz., the Hudson, the Helderberg, the Hamilton and the Coal Measures. Prof. Newberry claimed that each of the circles of sediments was formed by an invasion of the land by the sea, producing, first a sheet of sea-beach sand and gravel; second, the off-shore deposits following and covering the first; third, the open sea calcareous, organic deposits—a limestone; fourth, a mixed sediment—shale and limestone, or an earthy limestone—the product of the retreating sea. Between these submergences perhaps millions of years elapsed, in which the fauna of the sea and the flora of the land were changed. Hence the different fossils of the different systems.

THE PROXIMATE FUTURE OF NIAGARA.

By Prof. G. W. Holley.

Prof. Tyndall said that if the rate of recession named by Sir C. Leyell, a foot a year, was correct, in 5,000 years the Horseshoe Falls would be far above Goat Island, and the American channel would be dry. Prof. Holley showed that Sir Charles's rate was the result of a conjecture founded on a guess. He also, by means of the most trustworthy data we have since the commencement of the historic period, showed that it would be more than twice that length of time before the falls would recede a mile.

He further described the formation of the bottom of the river, the course and depth of the different currents and the location of the bars, all which indicated that the American channel would never be without water.

Prof. Tyndall thinks that the depth of the water will determine the course of the chasm channel as the gorge recedes, and the rate of excavation. Prof Holley cited the physical facts which tend to prove that it is the character of the bed of the river, the harder or softer nature of the material to be broken down, that will decide these points. He particularly noticed the fact that the Falls were constantly diminishing in height as they receded, until they reached their present site, where the river makes an acute angle with its former direction. This was necessarily the case, because they were receding in the line of the dip of the underlying rock. They are now rising on the dip, and will be 50 feet higher than now when they are two miles up stream. To this bend in the river we owe one of the most beautiful features of the great cataract—the rapids above the Falls.

Prof. Tyndall speaks of his trip through the Cave of the Winds and of seeing the shale in it; also of the "blinding hurricane of spray which was hurled against him." Prof. Holley said it was this last circumstance which probably prevented Prof. Tyndall from noticing the fact that no shale whatever is visible in the cave. Prof. Holley closed by saying that Prof. Tyndall's style was so vigorous, animated, and positive that one might be excused if he preferred to read Tyndall's romances rather than the most realistic utterances of many of his brother scientists.

NEW THEORY OF GEYSER ACTION AS ILLUSTRATED BY AN ARTIFICIAL GEYSER.

By Edmund Andrews.

This paper stated Bunsen's theory of geysers as illustrated by Tyndall's apparatus, and showed the objections to this theory, the phenomena not corresponding to those of the natural geysers. The theory advocated in Mr. Andrews' paper is, that as the cooler waters of the surrounding country make their way into and through the caverns of the region of heated rocks, it will sometimes happen that the channel of supply will enter a cavern at a point higher than that where the channel of exit leaves it. If, now, this channel of supply has, like many other subterranean water-courses, some portion of its course much lower than the point of its entry into the cavern, we have all the main conditions necessary for a geyser. Suppose that all these caverns and passages are full of water, the rocks of the cavern heated, and with, perhaps, the addition of superheated steam from lower crevices. The pressure of steam accumulating in the top of the cavern will resist the further supply of cool water from the supply channel, and perhaps force it back to a point where the hydrostatic pressure of the column balances the pressure of the steam, which meanwhile accumulates sufficiently to force out the water in a jet into the external air. While the water in the cavern is above the orifice of exit, the jet will consist only of water, but when the cavern is emptied to the level of the outlet pipe, the steam will escape and relieve the pressure. Then the cool water of the supply channel, rushing in without resistance, cools the cavern and fills it, preparatory to a new eruption, when the water is again heated to boiling point. Diagrams of the natural geyser and of an artificial one, constructed to illustrate it, were exhibited and explained.

THE CHEMICAL COMPOSITION OF A COPPER MATTE.

By Prof. T. Sterry Hunt.

The name of matte or regulus is given to a product obtained in smelting partly roasted sulphuretted copper ores, and consisting in great part of sulphur and copper. It is the result of a process of concentration. A specimen of this, holding 45 per cent. of copper, beside iron and sulphur, was found to give up the greater part of its iron to dilute acids, with the escape of free hydrogen and sulphuretted hydrogen gases. It precipitated metallic copper and metallic lead abundantly from their solution, and contained apparently the greater part of its iron in a metallic state. When oxidised by nitric acid or bromine, it left a residue of more than ten per cent. of grains of pure magnetic oxide of iron, and the dissolved portion contained about thirteen equivalents each of copper and sulphur, beside eight of iron and a little zinc. It was, as might be expected, strongly magnetic.

The author insisted upon the apparent anomaly exhibited in the association in a furnace product of a stable oxide of iron in presence of a sulphuret, the affinities being curiously balanced in the fused mass. The presence of metallic iron at the same time he explained as the result of a partial dissociation of the double sulphuret on cooling. His inquiries in this matter are not yet finished, but throw an unexpected light on some furnace reactions, as the treatment of iron in the Bessemer process, and also on the production in nature of many igneous rocks.

EMBRYOLOGY OF LIMULUS, WITH NOTES ON THE AFFINITIES.

By A. S. Packard, M.D.

In a recent paper on the embryology of Limulus, published in the memoirs of the Boston Society of Natural History, I stated that the blastodermic skin just before being moulted consisted of nucleated cells; and also traced its homology into the so-called amnion of insects. I have this summer, by making transverse sections of the egg, been able to observe in a still more satisfactory manner these blastodermic cells and observe their nuclei before they become effaced during or after the blastodermic moult.

On June 17 (the eggs having been laid May 27) the peripheral blastodermic cells began to harden, and the outer layer—that destined to form the amnion—to peel off from the primitive band beneath. The moult is accomplished by the flattened cells of the blastodermic skin hardening and peeling off from those beneath; during this process the cells in this outer layer losing their nuclei, and, as it were, drying up, contracting and hardening during the process. This blastodermic moult is comparable with that of Apus, as I have already observed, the cells of the blastodermic skin in that animal being nucleated.

The paper set forth that while the process above described resembled features in the development of the scorpion, and thus strengthened the supposition of Burmeister, that the Limulus is related to the spiders, nevertheless other features which Prof. Packard pointed out led him to believe that the Limulus is related to the lower crustaceans, but is, like all the earlier or palæozoic types, comprehensive or synthetic, comprising certain features belonging to higher forms, while yet holding its proper affinities with the lower ones. He also confirmed the brilliant researches of A. Milne Edwards upon this representative of an ancient type.

GENITALIA AND EMBRYOLOOGY OF THE BRACHIOPODA.

By Prof. EDWARD S. MORSE, of Salem, Mass.

The papers read on this subject by Prof. E. S. Morse, of Salem, Mass, showed that the brachiopods were the only class of animals of which the developmental history has been hitherto unknown. So dark has been this department of zoölogy, that an eminent German naturalist, Oscar Schmidt, published but a single figure of a young brachiopod as an important contribution to existing knowledge. Lacaze-Duthier had been the only one to give a few figures of an embryo brachiopod until Prof. Morse last year contributed sketches of a native species, confirming the investigations of the French naturalist.

Before going further it may be well to give unscientific readers a notion of what kind of an animal the brachiopod is, and why so great interest centres upon this group. One of Cuvier's memoirs, as early as 1802, was upon one of this class of animals. Hancock and Davidson of England have each received gold medals from the Royal Society for their contributions on this subject. Eminent German naturalists have written memoirs upon it. Prof. Huxley has made it the subject of special study. The reason for this peculiar interest among naturalists is that the very earliest fossiliferous remains—those deposited in the most ancient rocks—are members of this class. They are moreover found in rocks of all subsequent ages, and are still living in the seas of the present day. Singularly enough, while all other groups of animals have changed in their distinctive features, and many have become extinct, there are brachiopods of the present day that can scarcely be distinguished from their most ancient representatives. They are a closed type, having no branches, and may be therefore considered as a royal family among animals, their line of descent having been unbroken and untainted since the very dawn of life. But like other ancient families, their numbers have seriously diminished, and their line is probably in process of extinction.

The brachiopod is a small animal, enclosed in a bivalve shell, and adhering by a posterior appendage to the ocean floor. The possession of this bivalve shell has led all naturalists to include brachiopods among the mollusks. Three years ago Prof. Morse after a long and patient study of the living forms, startled the world of naturalists by announcing his conviction that the animals were not mollusks, and that they had no relations with shell fish whatever, but were true worms. Radical as was this innovation in classification, it received the sanction of several eminent naturalists, both at home and abroad. But before this new view could secure general acceptance, it was necessary that the obscure and almost unknown history of the animal from the egg to the adult should be fully ascertained. This Prof. Morse has at last accomplished. He has succeeded in raising the brachiopod from the egg and has studied its internal and external structure in every stage of growth. So to speak, he has seen it in its infancy and childhood, and dissected every portion of it under the microscope, drawing, as he can, with one hand and writing a description with the other, while his eye was glued to the instrument.

Briefly then, the embryo commences life as a little worm of four segments, and after enjoying itself in swimming freely in the water for a while, attaches itself to the sea bottom by its posterior segment, and settles permanently. The middle segment then protrudes on each side of the head segment, and gradually incloses it, thus producing the dorsal and ventral shell so characteristic of the entire class. This unlooked for, simple development could not have been predicated by any study of the adult animal, but remarkably sustains the homologies insisted upon two years ago by Prof. Morse in his papers upon the subject. The present communication elicited warm approbation.

ON SOME EXTINCT TYPES OF HORNED PERISSODACTYLES.

By Prof. EDWARD D. COPE, of Philadelphia.

It is well known that the type of *Mammalia* of the present period, which is preëminently characterised by the presence of osseous horns, is that of the *Artyodactyla Ruminantia*. At the meeting of the Association of last year, held at Dubuque, I announced that the horned mammals of our Eocene period were most nearly allied to the Proboscidians. I now wish to record the fact, as I believe for the first time, that the Perissodactyles of the intermediate formation of the Miocene embraced several genera and species of horned giants not very unlike the *Loxolophodon* and *Uintatherium* in their horned armature.

While exploring in connection with the United States Geological Survey of the Territories, I discovered a deposit of the remains of numerous individuals of the above character, which included among other portions crania in a moderately good state of preservation. Most of these skulls are nearly or quite three feet in length, and mostly deprived of their mandibular portions; these are quite abundant in a separated condition. The crania represent at least three species, while the mandible presents a condition distinct from that of *Titanotherium* or any allied genus. The teeth diminish rapidly in size anteriorly, and there is no disastema behind the canines, whose conic crowns do not exceed those of the premolars in length. To the genus and species thus characterized I have elsewhere given the name of *Symborodon torvus.*

One of the crania, referred to under the name of *Miobasileus ophagus,* is characterized by its strong and convex nasal bones and concave superior outline posteriorily, and by the presence of a massive horn-core on each side of the front whose outer face is continuous with the inner wall of the orbit, precisely as in the *Loxolophodon cornutus.* It stood above the eye in life, and diverged from its fellow so as to overhang it. In the specimen, which was fully adult, they were worn obtuse by use—length, about eight inches; thickness, three inches. The molar teeth differ from those of *Titanotherium Proutii* in having cross crests extending inward from the apices of the outer chevrons, each of which dilates into a T-shape near the cones.

The third species is for the present referred to *Megaceratops,* under the name of *M. acer.* It has overhanging eye-brows and the vertex little concave, but the nasal bones are greatly strengthened, and support on each side near the apex a large curved horn core of ten inches in length with sharply compressed apex. These bones diverge with an outward and backward curve, and when covered with their sheaths must have considerably exceeded a foot in length. This was a truly formidable monster, considerably exceeding the Indian rhinoceros in size.

The fourth species is allied to the last, and has well developed superciliary crests without horns. The latter are situated well anteriorly, and are short tubercles not more than three inches in height. They are directed outward, and have a truncate extremity. The type individual is of rather larger size than those of the other species. There are several crania referable to the three now named. The present one has been named *Megaceratops hiloceros.*

It was thought probable that some of the species based upon crania would be found to belong to the genus *Symborodon.*

These animals show true characters of the *Perissodactyla* in their deeply excavated palate, solid odontoid process, third trochanter of femur, which has also a pit for the round ligament; in the divided superior ginglymus of the astragalus, etc.

ON A SIGILLARIA SHOWING MARKS OF FRUCTIFICATION.

By J. W. Dawson, L.L.D.

The speaker explained in detail the nature of the leaf-scars and marks of growth of this remarkable tree of the coal formation, and then proceeded to describe the scars left on the specimen in question, which showed the girdles of scars left by the fall of the fruit. He showed that this could not have been of the nature of strobiles or cones, but must have been borne on separate modified leaves after the manner of some Cycads. The specimen belonged to a new species soon to be described by him, and closely allied to *S. Lalayana* of Schimper.

ON THE QUESTION "DO SNAKES SWALLOW THEIR YOUNG?"

By G. Brown Goode, of Middletown University, Conn.

This paper discussed the habit observed in certain snakes of allowing their young a temporary refuge in their throats, whence they emerge when danger is past. He stated that the question had been a mooted one since the habit was first discussed by Gilbert White in his "Natural History of Selborne," published in 1789. Reference was made to the views of Sir William Jardine, M. C. Cooke and Prof. F. W. Putnam, as well as the recent discussion of the subject in *Land and Water.*

The question can only be decided by the testimonies of eye-witnesses. Through the courtesy of the editors of *The American Agriculturist* a note was inserted asking for observations. By this means and by personal inquiry the testimony of 96 persons had been secured. Of these 56 saw the young enter the parent's mouth, in 19 cases the parent warning them by a loud whistle. Two were considerate enough to wait and see the young appear when danger seemed to be past, one repairing to the same spot and witnessing the same act on several successive days. Four saw the young rush out when the parent was struck; 18 saw the young shaken out by dogs or running from the mouth of their dead parent; 29 who saw the young enter, killed the mother and found them living within, while only 13 allowed the poor parent to escape; 27 saw the young living within the parent. But as they did not see them enter, the testimony is at least dubious.

It may be objected that these are the testimonies of laymen, untrained and unaccustomed to observation. The letters are, however, from a very intelligent class of farmers, planters, and business men—intelligent readers of an agricultural magazine. In addition, we have the testimony of several gentlemen whose word would not be doubted on other questions in zoölogy. There were given the statements of Prof. S. I. Smith of Yale College, Dr. Edward Palmer of the Smithsonian Institute, the Rev. C. L. Loomis, M.D., of Middletown, Conn., and others; and the statement of the editor of *The Zoölogist* regarding the Scaly Lizard of Europe (*Zoötoca vivipara*), which has a similar habit.

In the opinion of Profs. Wyman and Gill and other physiologists, there is no physical reason why the young snakes may not remain a considerable time in the dilatable throat and stomach of the mother. The gastric juice acts very feebly upon living tissues, and it is almost impossible to smother reptiles. Toads and frogs often escape unharmed from the stomach of snakes. If the habit is not protective, if the young cannot escape from their hiding place, this habit is without parallel; if it is protective, a similar habit is seen in South American fishes of the genera *Arius*, *Bagrus*, and *Geophagus*, where the male carry the eggs for safety in their mouths and gill-openings.

Since many important facts in biology are accepted on the statements of a single observer, it is claimed that these testimonies are sufficient to set this matter forever at rest. The well attested cases relate to the garter snake and ribbon snake (*Eutania sirtalis* and *saurita*), the water snake (*Tropidonotus sipedon*), the rattlesnake (*Caudisona horrida*), the copperhead and moccassin (*Agkistrodon contortrix* and *piscivorus*), the massasauga (*Crotalus tergeminus*), the English viper (*Pelias berus*), and the mountain black snake (*Coluber Alleghaniensis*). It is probable that the habit extends through all the species of the genera represented, as well as throughout the family of *Crotalidæ*. It is noteworthy that all these snakes are known to be ovoviviparous, while no well attested case occurs among the truly oviparous, milk snakes (*Ophibolus*), grass snakes (*Liopeltis* and *Cyclophis*), ground snakes (*Storeria*), or the smooth black snakes (*Bascanion constrictor*). It yet remains to be shown that the habit is shared by egg-laying snakes. Further observations are much needed, as the breeding habits of more than 25 North American genera are entirely unknown

NOTES ON PROTOTAXITES.

Mr. Carruthers, of the British Museum, having published in the "Monthly Microscopical Journal," some criticisms on *Prototaxites Logani* from the Devonian of Gaspé, which he argues may have been a gigantic sea-weed, Principal Dawson replies in the same Journal. The following abstract of the reasons for regarding Prototaxites as a conifer is deserving of publication here, as the species was first noticed in this Journal.

1. *Mode of Occurrence.*—This alone should suffice to convince any practical palæontologist that the plant cannot be a sea-weed. Its large dimensions, one specimen found at Gaspé Bay being three feet in diameter; its sending forth strong lateral branches, and gnarled roots; its occurence with land plants in beds where there are no marine organisms, and which must have been deposited in water too shallow to render possible the existence of the large oceanic Algæ to which Mr. Carruthers likens the plant. These are all conditions requiring us to suppose that the plant grew on the land. Further, the trunks are preserved in sandstone, retaining their rotundity of form even when prostrate; and are thoroughly penetrated with silica except the thin coaly bark. Not only are Algæ incapable of occurring in this way, but even the less dense and durable land plants, as Sigillariæ and Lepidodendra are never found thus preserved. Only the extremely durable trunks of coniferous trees are capable of preservation under such circumstances. In the very beds in which these occur, *Lepidodendra*, tree ferns and *Psilophyton*, are flattened into mere coaly films. This absolutely proves, to any one having experience in the mode of occurrence of fossil plants, that here we have to deal with a strong and durable woody plant.

2. *Microscopic Structure.*—It would be tedious to go into the numerous scarcely relevant points which Mr. Carruthers raises on this subject. I may say in general that his errors arise from neglect to observe that he has to deal not with a recent but a fossil wood, that this wood belongs to a time when very generalized and humble types of gymnosperms existed, and that the affinities of the plant are to be sought with Taxineæ, and especially with fossil Taxineæ, rather than with ordinary pines.

Mr. C., after describing Prototaxites according to his own views of its structure, expresses the opinion that "the merest tyro in histological botany" may see that the plant could not be phænogamous. But if the said tyro will take the trouble to refer to the beautiful memoir on the Devonian of Thuringia, by Richter and Unger,* and to study the figures and descriptions of *Aporoxylon primigenium*,† *Stigmaria annularis*, *Calamopteris debilis*, and *Calamosyrinx Devonicus*, he will find that there are Devonian plants referred by those eminent palæontologists to Gymnosperms and higher Cryptogams, which fall as far short of Mr. Carruthers' standard as Prototaxites itself. Nothing can be more fallacious in fossil botany than comparisons which overlook the structures of those primitive palæozoic trees which in so many interesting ways connect our modern gymnosperms with the cryptogams.

It is scarcely necessary to reply to such a statement as that the fibres of Prototaxites have no visible terminations. They are very long, no doubt, and both in this and their lax coherence they conform to the type of the yews. In Mesozoic specimens of *Taxoxylon* which I have now before me, the fibres are nearly as loosely attached and as round in cross section as in Prototaxites. In these, as in Prototaxites, water-soakage has contributed to make the naturally lax and tough yew-structure less compact, and to produce that appearance of thickness of the walls of the fibres which is so common in fossil woods.

Disks or bordered pores in Prototaxites I did not insist on, the appearance being somewhat obscure; but Mr. Carruthers need not taunt me with affirming the existence of such pores in the walls of cells not in contact. Pores, if not bordered pores, may exist on such cells, and the wood cells of Prototaxites are in contact in many places, as may easily be seen, and even where they appear separate, this separation may be an effect of partial decay of the tissues.

Mr. Carruthers converts the spiral fibres lining the cells of Prototaxites into tubes connecting the cells. This is a question of fact and vision, and I can only say that to me they appear to be solid, highly refracting fibres; and under high powers, precisely similar to those of fossil specimens of Taxoxylon from

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* Trans., Vienna Academy, 1856.

† I have elsewhere compared Aporoxylon with Prototaxites, 'Jour. Geol. Soc.' 1862, p. 306. Report on Devonian plants.

British Columbia, and to those seen in charred slices of modern yews. I may further say that Mr. Carruthers' figure is in my judgment to a great extent imaginary.

But what of the arrangement of these fibres. It is true that, as I have stated, they appear in some cases to pass from cell to cell, and I hesitated to account for this appearance. The possibilities of such an appearance, as yet, perhaps, unknown in the plant-rooms of the Museum, result from the following considerations: (1.) In more or less crushed fossil plants, it is not unusual to see what are really internal structures appearing to pass beyond the limits of the cell-wall, from the mere overlapping of cells. I have good examples in the Mesozoic Taxoxylon already mentioned. (2.) In fossil woods the original cell-wall is often entirely destroyed, and only the ligneous lining remains, perhaps thickened by incrustation of mineral matter within. In this case the original lining of the cell may seem to be an external structure. I have examples both in Mesozoic conifers and in carboniferous plants. Long soaking in water and decay have thus often made what may have been a lining of wood-cells appear as an intercellular matter, or an external thickening of the walls. (3.) In decayed woods the mycelium of fungi often wanders through the tissues in a manner very perplexing; and I suspect, though I cannot be certain of this, that some fossil woods have been disorganized in this way. At the time when my description was published, I felt uncertain to which of these causes to attribute the peculiar appearance of Prototaxites. I have now, from subsequent study of the cretaceous Taxineæ of British Columbia,* little hesitation in adopting the first and second explanations, or one of them, as probable.

Mr. Carruthers does not believe in the medullary rays of Prototaxites. The evidence of these is the occurrence of regular lenticular spaces in the tangential section, which appear as radiating lines in the transverse section. The tissues have perished; but some tissues must have occupied these spaces; and in fossil woods the medullary rays have often been removed by decay, as one sometimes sees to be the case with modern woods in a partially decayed state. Mr. Carruthers should have been more cautious in this matter, after his rash denial, on similar grounds, of medullary rays in Sigillaria and Stigmaria, contrary to the testimony of Brongniart, Goeppert, and the writer, and the recent exposure of his error by Professor Williamson. That the wood-cells have been in part crushed into the spaces left by the medullary rays is only a natural consequence of decay. The fact that the medullary rays have decayed, leaving the wood so well preserved, is a strong evidence for the durability of the latter. The approval with which Mr. C. quotes from Mr. Archer, of Dublin, the naïve statement that "the appearance of medullary rays was probably produced by accidental cracks or fissures," would almost seem to imply that neither gentlemen is aware that radiating fissures in decaying exogenous woods are a consequence of the existence of medullary rays, [or that water-soaked wood cannot be cracked in this way.]

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* Report of Geol. Survey of Canada, now in course of publication. The collections contain wood showing the structure of yew, cypress, oak, birch, and poplar, all from rocks of cretaceous age.

Perhaps the grossest of all Mr. Carruthers' histological errors is his affirming that some of my specimens of Prototaxites show merely cellular structures, or are, as he says, "made up of spherical cells." Now, I affirm that in all my specimens the distinct fibrous structure of Prototaxites occurs, but that in parts of the larger trunks, as is usual with fossil woods, it has been replaced by concretionary structure, or by that pseudo-cellular structure which proceeds from the formation of granular crystals of silica in the midst of the tissues. Incredible though it may appear, I know it to be a fact, as all the specimens I gave to Mr. Carruthers had been sliced and studied by myself, that it is this crystalline structure which the botanist of the British Museum mistakes for vegetable cells.* I think it right to state here that I not only gave Mr. C. specimens in these different states of preservation, but that I explained to him their nature and origin.

3. *Affinities.*—In discussing these I must repeat that we must bear in mind with what we have to deal. It is not a modern plant, but a contemporary of that "prototype of gymnosperms" *Aporoxylon*, and similar plants of the Devonian. Further, the comparison should be not with exogens in general, or conifers in general, but with Taxineæ, and especially with the more ancient types of these. Still further, it must be made with such wood partly altered by water-soakage and decay and fossilized. These

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* In fossil-woods, the carbonaceous matter, being reduced to a pulpy mass, sometimes partly becomes moulded on the surfaces of hexagonal or granular crystals, in such a manner as to deceive very readily an observer not aware of this circumstance.

necessary preliminaries to the question appear to have been altogether overlooked by Mr. Carruthers.

My original determination of the probable affinities of Prototaxites, as a very elementary type of taxine tree, was based on the habit of growth of the plant—its fibrous structure, its spirally-lined fibres, its medullary rays, its rings of growth, and its coaly bark, along with the durable character of its wood, and its mode of occurrence; and I made reference for comparison to other Devonian woods and to fossil taxine-trees.

Mr. Carruthers prefers to compare the plant as to *structure* with certain chlorospermous Algæ, and as to *size* with certain gigantic Melanosperms, not pretended to show similar structure. This is obviously a not very scientific way of establishing affinities. But let us take his grounds separately. He selects the little jointed calcareous sea-weed *Halimeda opuntia*, as an allied structure, and copies from Kutzing a scarcely accurate figure of the tissue of the plant as seen after the removal of its calcareous matter.* He further gives a defective description of this structure; whether taken from his own observation or from Kutzing, he does not say. Harvey's description, which I verified several years ago, in an extensive series of examinations of these calcareous Algæ, undertaken in consequenceof a suggestion that Eozoön might have been an organism of this nature, is as follows:—"After the calcareous matter of the frond has been removed by acid a spongy vegetable structure remains made up of a plexus of slender longitudinal unicellular filaments constricted at intervals, and at the constrictions emitting a pair of opposite decompound, dichotomous, corymboso-fastigiate horizontal ramelli, whose apices cohere and form a thin epidermal or peripheric stratum of cells." It will be seen at once that this structure has no resemblance whatever to anything existing in Prototaxites, even as interpreted by Mr. C., and without taking into account the fact that *Halimeda opuntia* is a small calcareous sea-weed, divided into flat reniform articulations, to which this structure is obviously suited, as it would be equally obviously unsuited to the requirements of a thick cylindrical trunk, not coated with calcareous matter.

In point of size, on the other hand, Mr. Carruthers adduces the great *Lessonia* of the Antarctic seas, whose structure, however, is not pretended to resemble that of Prototaxites except in the vague statement of a pseudo-exogenous growth. *Lessonia* I have not examined, but the horny *Laminariæ* of our North American seas have no resemblance in structure to Prototaxites.

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* A more characteristic [illegible] ven in Harvey's "North American Algæ."

Nothing further, I think, need be said in reply to Mr. Carruthers' objections; and *Nematophycus* may be allowed to take its place along with a multitude of obsolete fucoids which strew the path of palæontology. As to Prototaxites, it is confessedly an obscure and mysterious form, whose affinities are to be discussed with caution, and with a due consideration of its venerable age and state of preservation, and probably great divergence from any of our modern plants; and it is to be hoped that ere long other parts than its trunk may be discovered to throw light on its nature. Until that takes place, the above remarks will be sufficient to define my position in regard to it; and I shall decline any further controversy on the subject until the progress of discovery reveals the foliage or the fruit of this ancient tree, belonging to a type which I believe passed away before even the Carboniferous flora came into existence.

GEOLOGY AND MINERALOGY.

Bone Cave in Kirkcudbrightshire.—It has long been familiar to geologists that the western and southern coast-line of Scotland is pierced with caves of different levels, indicating former successive lines along which the sea-waves worked. Unfortunately, owing to the want of limestone, or very calcareous rocks, these caves, as a rule, present none of that stalagmite deposit which has elsewhere served so abundantly to cover over and preserve the remains of the ancient denizens of our country, with traces of the presence of man himself. The caves usually open directly upon the coast, with free exposure to the air, so that the floors show nothing but damp boulders and pools of water from the drip of the roof. Recently, however, a remarkable exception to these ordinary conditions has been observed on the wild cliff-line to the south-west of the bay of Kirkcudbright. The Silurian greywacke is there traversed with strings and veins of calcite along lines of joint and fracture, and at one point where an old sea cave occurs, the walls and floor at the cave mouth, and for a few yards inwards, have a coating of solid calcareous matter. Beneath this coating in the substance of the breccia which extends across the cave mouth, as well as throughout the cave earth behind the breccia, a great quantity of bones, with traces of human occupation, have been found. A systematic investigation of the cave, commenced last autumn, is being carried on under the direction of Mr. A. J. Corrie and Mr. W. Bruce-Clarke—the discoverers of the osseous layer. At the present time the following among other remains have been noted: bones of ox, red deer, goat, horse, pig, pine-marten, rabbit, watervole, and other small rodents, together with numerous remains of birds and a few frog and fish bones. Intermingled with these occur fragments of bronze, bone needles, and other bone implements, to the number of more than twenty; one piece of worked stone (a fragment of greywacke) has been found, but as yet not a single chip of flint. A full account of the cave will be published as soon as the investigations are completed.—*Geological Magazine.*

FOSSILS OF THE LOWER POTSDAM ROCKS AT TROY, N. Y.—In the August number of the American Journal of Science, Mr. S. W. Ford gives a list of the fossils found in these rocks, including several which he considers as new—*Microdiscus speciosus*, *Leperditia Troyensis*, and a bivalve of uncertain affinities. Judging from its fauna he concludes that the Troy series of rocks is of nearly if not exactly the same age as the Olenellus or Georgia slates of Vermont, and the Olenellus limestones on the north shore of the Straits of Belle Isle. The fauna is quite distinct specifically from that of the Upper Potsdam of Wisconsin and the true Potsdam of New York, as well as from that of the more ancient St. John's or Menevian group of New Brunswick and its equivalent in the Primordial of Newfoundland; but is connected with each of them generically.

SAPONITE.—This mineral occurs in cavities in the trap of George or Hog Island, a small island in Richmond Bay, on the north coast of Prince Edward Island. It is grayish-white to grayish-green in color; subtranslucent before exposure to the air, but afterwards becoming opaque and white. Massive and very soft, but becoming brittle on drying. Sp. gr. 2.23—2.27. Before the blowpipe becomes opaque and fuses at about 4. In the closed tube gives off water. Decomposed by sulphuric acid. The following is the mean of two analyses:

Silica	43.91
Alumina	6.47
Peroxide of Iron	1.23
Lime	.59
Magnesia	27.18
Water	19.64
	99.02

B. J. H.

PHOSPHATIC CHARACTER OF THE SHELLS OF OBOLUS.—Analyses by A. Kupffer show that the shells of Lower Silurian *Obolus* have nearly the composition of a fluor-apatite. He obtained from a specimen from Jamburg in Ehstlands,

PO_5	CO_2	Fl	Fe_2O_3	MgO	CaO	ign.	quartz	
36.57	2.42	3.31	4.90	0.62	50.47	2.57	0.53	= 101.39

from which, deducting the oxygen in excess, on account of the fluorine, 1.59, leaves 99.80.

A concretion of Trilobite shells contained, according to the same chemist, PO_5 19,45, CaO 45.06, CO_2 16.45, Fl 2.88, with a little FeO, MgO, and 6.80 of volatile matters mainly bituminous, corresponding to 42.46 phosphate of lime, 31.81 carbonate, 5.91 fluorid of calcium, with some carbonate of iron and other impurities.—*Am. Jour. Sc.*

BOTANY AND ZOOLOGY.

THE FERTILIZATION OF GRASSES.—Prof. Hildebrand, a German botanist who has paid great attention to the subject of the fertilization of flowering plants, has recently made an important series of observations on the fertilization of grasses, and especially of cereals. The agent of fertilization in all grasses, except those few in which the flowers never open, is the wind, insects apparently playing no part in it. With this object the pollen grains are very fine and smooth, so that they are at once dispersed by a breath of air; the filaments are usually not stiff, but versatile, and the stigma is either feathery, or presents a large surface with numerous indentations in which the pollen is easily lodged. These contrivances render cross-fertilization inevitable; and, while self fertilization is in most cases not absolutely prevented, it is generally rendered very difficult. Many species, however, which are ordinarily cross-fertilized never open their flowers when the weather is cold and rainy, and are, in such circumstances, necessarily self-fertilized. In grasses with unisexual flowers, cross-fertilization must take place as a matter of course. In those with hermaphrodite flowers a few are protogynous, and hence also necessarily cross-fertilized. In the larger number of grasses, however, the male and female organs are developed at the same time, and special contrivances occur for ensuring cross-fertilization. In the rye the position of the organs is such that a part of the pollen from one flower must almost necessarily fall on the stigma of another flower. In the wheat each separate flower remains open only for an extremely short time, the glumes separate from one another suddenly, the anthers immediately protruding, and a large quantity of the pollen is dispersed into the air, the whole process not occupying more than half a minute. In most of these cases the stigma remains receptive only for a very short period and then dies, while in others the stigma remains in a receptive condition till long after the anthers have dropped off, and then must necessarily be open to the access of foreign pollen. In comparatively few cases the natural contrivances appear to favor self- rather than cross-fertilization. Thus in the oat and barley the majority of the flowers never open, and are, therefore, necessarily self-fertilized; there appear, however, in almost all cases to be a small number of flowers, often arranged in one or two separate rows, which do open, and therefore may introduce occasional cross-fertilization. It is probable that the same species behaves differently in relation to its arrangements for fertilization under different circumstances of climate, while species very nearly related exhibit phenomena which offer a marked contrast.—*American Naturalist.*

SPHAGNUM AND HYPNUM PEAT.—The opinion seems to have been somewhat prevalent that peat does not accumulate abundantly in limestone regions, but this is not true of large portions of some of the northern interior states. For example, all the peat of Iowa is in an eminently limestone region, and the water taken out of any of the marshes shows a strong reaction for lime by proper chemical tests.

From my own observations I believe that Sphagnum peat does not accumulate in limestone regions, but that the peat mosses of such regions all belong to the genus Hypnum. I have found no other moss entering into the composition of Iowa peat.

Another fact observed in this connection has doubtless much significance, namely, the Ericaceæ are almost entirely wanting in Iowa, and no plants of that order have yet been observed by myself in or about these Hypnum marshes. The principal plant assisting the Hypnum in the production of peat is a kind of grass.

Should one go north from Iowa or Illinois into the metamorphic regions of Minnesota and Wisconsin, I think he would see the Hypnum gradually give place to Sphagnum in the marshes, and the marsh Ericaceæ appear with the last named moss.

In short, lime seems to be an uncongenial element in the habitat of both Sphagnum and most if not all ericaceous plants, but is not uncongenial to Hypnum and grass. Therefore the abundant presence of lime will not necessarily prevent the accumulation of peat.—*Ibid.*

CIRCULATION IN THE KING CRAB.—M. Alphonse Milne-Edwards finds that the circulating apparatus of Limulus is more perfect and complicated than that of any other articulate animal. The venous blood, instead of being diffused through interorganic lacunæ, as in the crustacea, is, for a considerable portion of its course, enclosed in proper vessels with walls perfectly distinct from the adjacent organs, originating frequently by ramifications of remarkable delicacy, and opening into reservoirs which are for the most part well circumbscribed. The nutritive liquid passes from these reservoirs into the branchiæ, and, after having traversed these respiratory organs, arrives by a system of branchio-cardiac canals, in a pericardiac chamber, then penetrates into the heart, of which the dimensions are very considerable. It is then driven into tubular arteries with resistant walls, the arrangement of which is exceedingly complex, with frequent anastomoses, and of which the terminal ramifications are of marvellous tenuity and abundance. He has also found, as Prof. Owen had intimated, that the nerves are completely ensheathed by the blood vessels. —*Annals and Mag. Nat. History.*

In the *Chronique de la Société d'Acclimatation*, M. Ruimet states that by feeding silk-worms on vine-leaves he has obtained silk of a fine red colour; and that by giving the worms lettuce-leaves, they have produced cocoons of an emerald-green colour. M. Delidon de St. Gilles, of Vendée, has also, by feeding silk-worms—during the last twenty days of the larva period—on vine, lettuce, and nettle-leaves, obtained green, yellow, and violet cocoons.—*Athenæum.*

A collection of freshwater fishes, made at Shanghai by H.M. Consul, Mr. R. Swinhoe, has been reported on by Dr. A. Günther, of the British Museum. The collection is notable for containing an unusually large proportion of new species, or such as have hitherto been but imperfectly known.—*Ibid.*

CHEMISTRY.

Synthesis of Marsh Gas and Formic Acid.—Sir B. C. Brodie has found that if a mixture of hydrogen and carbon oxide is submitted to the action of electricity in the induction tube, a contraction of volume ensues accompanied with the production of marsh-gas. The reaction is expressed by the equation—

$$CO + 3H_2 = C_4 + H_2O.$$

It was also found that on treating a mixture of carbon dioxide and hydrogen in a similar manner, the resultant gas contained carbon oxide, while minute drops of an oily liquid collected in the tube. These gave the characteristic reactions of formic acid, and their production may be represented by the equation—

$$H_2 + CO_2 = H_2 CO_2$$

Note on Silicic Acid.—C. Rammelsberg has found that silica which after a short ignition, dissolves in a boling solution of potassium or sodium carbonate, loses this property, either partly or almost entirely, when it is subjected to a more prolonged and stronger ignition. Hence when the silica obtained in analysis is to be dissolved in potassium or sodium carbonate, this operation should be performed before its ignition.

The author has made a series of determinations of the water contained in silica obtained by the decomposition of an alkaline silicate, or of Wollastonite, and finds that this substance, when dried over oil of vitrol, contains 4·5 to 7 per cent of water, and that when it is dried at 100° to 140°, it retains from 4 to 5·7 per cent. of water. These numbers correspond to hydrates $n\mathrm{SiO}$ + Aq, in which n lies between 4 and 8. Air-dried silica retains 13 to 36 per cent. of water. The latter of these numbers corresponds to $\mathrm{SiO} + 2\mathrm{aq}$, and the former to $\mathrm{SiO_2} + \mathrm{Aq}$.

—*Jour. Chem. Soc.*

MISCELLANEOUS.

Professor Ward's Natural Science Establishment at Rochester, N. Y.—When Professor Agassiz gave his opening lecture in the Museum of Comparative Zoology at Cambridge in 1860, he said that American students had been forced to visit Europe if they were desirous of making any extended study in the natural sciences, but that he intended to reverse this and compel European students to visit America; and by his judicious purchase of type collections abroad (thanks to the liberality of citizens and our State) he has made his promise good.

Professor Henry A. Ward of Rochester, New York, formerly a student of Professor Agassiz, and since Professor of Geology and Zoology in the Rochester University, has, under humbler auspices, long been working toward the same end. His large cabinet of geology and mineralogy at Rochester is well known to many of our readers. He long ago felt the necessity of bringing before the American student examples of those larger and rarer fossils known to geological science, ot which only single specimens existed.

For this purpose he visited Europe, engaged accomplished workmen and commenced the foundation of a collection of casts. With untiring patience and sagacity he secured the moulds of nearly everything of importance, at enormous expense, carrying his workmen from one museum to the other, and taking moulds of the choicest specimens, for a period of three years.

The difficulties encountered in some of his experiences would form an interesting chapter. After many difficulties, he managed to secure moulds of rare Megatherium, Glyptodon, Deinotherium, Diprotodon, Sivatherium, Colossochelys, Mosasaurus, Plesiosaurus, and many other unique specimens in European museums. Thorough and methodical in all his work, he felt that this collection of casts should be symmetrical and complete, as an educational collection, and so was commenced the famous Ward collection of casts. Thousands of dollars were spent in buying especially choice specimens of the obtainable forms solely for the purpose of making casts from them, and the originals are still preserved in his museum at Rochester. Every educational institution in the country may now possess perfect casts of the rarest fossils, forming exact facsimiles of the unique originals in the British Museum, the Jardin des Plantes, and other foreign museums, besides a representative collection of all that is needed to illustrate geological history.

From this important beginning, Professor Ward has gone on enlarging the usefulness of his work by adding to his stock, skins and skeletons of animals, fossils and minerals, and alchoholic specimens, so that institutions may provide themselves with collections accurately labelled and arranged, without sending abroad for the purpose.

With the capital invested in so large an enterprise, rapid sales must be effected, and one not familiar with the scientific attainments of Professor Ward, and the sole desire that animates him, to spread far and wide the type collections so important for educational purposes, might confound his occupation with that of the ordinary dealer in natural history objects, such as one may find in any large city. While in the latter case, however, with some laudable exceptions, the dealers offer simply the fortuitous gatherings of sailors, comprising curosities, shells, and detached portions of animals, like turtles' shields, sharks' jaws, and the like, of no intrinsic value, the work in which Prof. Ward is engaged is one of a solid scientific character. His outlays are immense, yet everything he does is done solely in reference to advancing science. He has the endorsement of every naturalist in the country, and already the leading museums in the country are indebted to him for some of their choicest material.

Every scientific man should visit Professor Ward's place at Rochester, New York, and see the bee-hive of industry he has built up around him. We visited Rochester in February, solely for the purpose of examining the new industry. Here one finds several large buildings, besides sheds and yards devoted to receiving, preparing and shipping specimens. There are twelve men constantly employed as taxidermists, osteologists, moulders and carpenters. Two of the osteologists he has brought from the Jardin des Plantes, Paris, where they had worked for a long time under the direction of eminent anatomists. The skeletons and skulls prepared here are beautiful in their whiteness and the elegance of their mounting. In the University building is Professor Ward's zoological cabinet, still his private property, containing type forms of the animal kingdom. This is carefully labelled and is strictly an educational collection.

In Cosmos Hall is a large room containing a large and valuable geological collection, particularly rich in Ammonites, fossil cuttle fishes, with the ink glands still preserved; beautiful fossil fishes from the Lias of England and Germany; fine Saurians in slabs; Icthyosaurus, Plesiosaurus, Teleosaurus; also the leg bones and other remains of the remarkable Dinornis from New Zealand; Mastodon and other mammal remains, and an almost perfect skeleton of the rare Glyptodon, the gigantic fossil armadillo.

Great interest attaches to this collection since it contains the original specimens of many of his casts, which have already a traditional value, now that so many institutions possess them. This series of *originals* is of intense interest, and will alone give tone and character to any geological cabinet in which they may be incorporated. In this room may also be seen relief maps and various models of geological import; many of these are familiar to College Professors through the descriptions and figures given in Ward's "Illustrated Catalogue." At the time of our visit he was packing a series of casts for the Syracuse University, and a Megatherium was being cast for Dartmouth College. A cast of the skeleton of this latter huge animal may be seen in the Geological Hall of the Smithsonian Institution at Washington, where it was placed by Professor Ward, and copies of it are already in several other museums together with other of his specimens. The series of casts have been invaluable in advancing the study of geology, as their possession is just as important to the instructor in this department, as the possessson of the manikin and skeleton is to the successful teaching of human anatomy.

The zoological portion of Professor Ward's establishment most interested us. Here all is on the same large scale. In bringing this collection together, Professor Ward has not only visited various portions of this country and Europe, Asia and Africa, but has correspondents all over the world, and is constantly receiving from them most varied and rare material. While we were there he had just finished the preparation of a giraffe, thirteen feet in height, and was unpacking boxes containing a moose from Nova Scotia, a caribou from Maine, a bear from Pennsylvania, a huge basking-shark from the Atlantic coast; and, from Professor Agassiz, a walrus, a small whale, and the rare Rocky Mountain goat, to be mounted for the Cambridge museum.

One building is devoted to taxidermy. The upper room in this building is a wonder to behold; hanging from the ceiling are hundreds of skins, including Apes, Monkeys, Wolves, Bears, Hyænas, Lions, Tigers, Sloths, Ant-eaters, Armadillos, Buffaloes, Deer, Elk, Moose, Giraffe, Yak, Wild Boar, Peccaries; besides an immense collection of such animals as Kangaroos, Echidna, Wombat, Tasmanian devil, Ornithorynchus, Thylacinus, and other rare skins. Some huge Alligators, Turtles, Iguanas and other reptiles completed the display. In an adjoining room are kept fishes, batrachians, and other specimens in alchohol; among these are Lepidosteus, Amia, Menopoma, Spatularia, Scaphiorynchus, Aspidonectes, and other American species of anatomical interest. Still another building is devoted exclusively to the preparation of skeletons; these are received with the flesh dried upon them, and are subjected to a long process of maceration and bleaching; over fifty vats are ready to receive them. These vats are all systematically numbered, and the most painstaking care is manifested to secure every bone so that each specimen may be perfect. Custom work is combined with all this; and hundreds of specimens are received from the museums of Cambridge, Boston, Salem, Philadelphia, Albany, and many of our colleges, for the purpose of being properly prepared and mounted.

We have dealt thus in detail that the public may know the true character of the enterprise in which Professor Ward is engaged; and the duty of every one interested in science and education to cordially sustain him.

Professor Ward has by long study and by travel in foreign countries, as well as by his long experience as a professional teacher of zoology and geology, fitted himself for the important and arduous task before him.

He has received the unqualified endorsement of the leading naturalists, and his untiring devotion to the work, and the immense outlays he has made, should be widely known among those who desire to sustain in this country an institution where one may secure the material for the foundation of a museum, as well as examples for educational purposes.—E. S. Morse.—*Am. Nat.*

[We have received from Prof. Ward a catalogue of the osteo logical specimens in his cabinet at Rochester. It is evidently prepared with much care, and, as each specimen has the price opposite it, will be very valuable to those wishing to procure osteological specimens for museums or private cabinets.—Ed. *Can. Nat.*]

OBITUARY.

Gustav Rose.—This distinguished mineralogist and chemist died at Berlin, July 15, in the 76th year of his age. In him Germany and the world have lost a wise and noble man,—conceded by all to be the first in his science among the learned men of Germany. He was the younger brother of Heinrich Rose, the chemist, and the youngest of four sons of Valentin Rose, who was Assessor in the "Ober-Collegium Medicum" of Berlin; and grandson of Valentin Rose the elder, discoverer of the "Rose'-schen" metals. He early lost his father, and his excellent mother looked after the culture of four sons, whose youth fell upon hard and trying times. All four brothers served their country in the war for freedom. Gustav, born on the 18th of March, 1798, and 17 years old at the date of the battle of Waterloo, did not go into that battle, but made the march under arms from Berlin to Orleans.

At first devoting himself to engineering, he fell sick of lung fever. During his convalesence he gave himself to scientific pursuits, and this, as well as the influence of his brother Heinrich, led him to leave engineering and devote himself entirely to science. He went to Stockholm where Heinrich was already working under the immortal Berzelius. In 1823 he took up his residence in Berlin. In 1826, he became "Extraordinary," and in 1839, "Ordinary" Professor of Mineralogy in the University of Berlin, and, after the death of Weiss, Director of the Royal Mineralogical Museum.

It was the privilege of Gustav Rose to travel extensively, in Scandinavia, England and Scotland, Italy and Sicily, France and Austria. In the year 1829, he made, with Humboldt and Ehrenberg, the famous tour to the Ural and Altai Mountains and the Caspian Sea, and beyond to the borders of China, a journey which first made known the mineralogical resources of the extensive Russian Empire. His researches on his native soil were confined to the Silesian Mountains.

G. Rose was the first in Germany to use the reflecting goniometer in accurate measurements of the angles of crystals. He took an active part in the researches which led Mitscherlich to the important discovery of isomorphism. His work covered all departments of mineralogy, the form and combinations of crystals, physics in its applications to crystallized substances, the chemical constitution of minerals, and their artificial formation. He was the great master in the art of crystallographic drawing. The science of the association of minerals in rocks, petrography, originated with him. He was also the first to teach us the method of studying rocks by means of thin microscopic sections mounted on glass slides, in which minerals invisible to the unaided eye are disclosed.

With a special predilection he devoted himself to the study of meteorites, those wonderful bodies which reach the earth from the depths of space. With his keen penetration he discovered the structure of the iron meteorites and the mineral components of stony meteorites, and studied out the striking differences between rock-making in a cosmic atom, and in the solid crust of the earth.

It is worthy of remark that his best mineralogical discoveries were made not always on rare bodies, but often on those which had been long familiar and were common in collections. An example of this is his recognition of right and left-handed quartz crystals by their exterior forms; the complex twin crystals of the same species, etc. The secret of his success was that he did not observe simply form, but all the physical characters of the species; when searching into nature's work, his mind grasped whatever in the wide range of facts could serve as a key to the solution of the difficult problem before him. During his later years his researches were devoted to the "king of stones," the diamond. Few mineralogists would have thought that the diamond yet offered unsolved problems. In his anxiety that his work should not be lost to science, only twenty-four hours before his death he dictated to his son the results of his latest researches. Perhaps the final solution of the problem of the crystallization of the diamond was not attained by him; but he was near reaching his aim. His life, in thought and action, reflected Bacon's maxim "Pertransibunt multi, sed augebitur scientia." He was a true student of nature, an eminent and effective worker for the progress of science and the exposition of the system of nature.

We can scarcely find a better example than in Gustav Rose of the joy from a growing knowledge of nature lasting to the evening of life. Looking back over his long life, he saw how many dark paths of science had been followed out and made clear. This filled him with delight and high hope. "You will yet have more light," he said to the young. "Much must perish, but science will continue to increase." He saw his co-workers and best friends, Mitscherlich, Magnus, Haidinger, above all. his brother Heinrich, called from their work. Their departure and his increasing loneliness filled him with pain. Still he rejoiced in the thought of how much science had been advanced by the common efforts of his departed friends. Thus his spirit exhibited the uncommon spectacle of augmenting cheerfulness to life's close. Three years since it was decided to celebrate his "Doktor-Jubiläum," on the occasion of his completing a half century as an instructor. He never sought honors, but nevertheless all honors fell to his share. When he was made Knight of the Order *pour la mérite*, he considered the distinction too great for him.

Imperishable is the memory which Gustav Rose has left. Not only imperishable, but a memory that is living and active in the hearts of all who knew him. In his science and his many-sided relations to life, he had no enemy, no opponent, no envy, no evil-wisher to disturb him. He lived in a profound peace, of which his eyes were the speaking witness, whose peculiar soul-full outlook astonished all with whom he spoke. What is often so hard to the best men, to live in peace and friendship, was allowed to him. As he always strove to judge from a sense of the good, the true and the beautiful, so he expected the same judgment from others. He recognized in the efforts of others only the good. If words and deeds did not accord with his views, he did not attribute to others evil motives—and thus he won to himself the love and respect of all who came in contact with him.

Gustav Rose, in his life, as well as in his science, has left us an example hard to imitate. Until the 11th of July he still gave his lectures. Notwithstanding his great debility,—feeling, he says, "as if I had climbed the "Hummerich" and the "Löwenburg,"—he wrote in the evening a long scientific letter, closing with the words "Rest will do us good; we will go again to our old quarters in Friedrichshafen; would we were there now!" Scarcely had he closed the letter when he was seized with a chill, the premonitory symptom of pneumonia, which, in less then four days ended the life of the best of men.

Now rests from its work the hand which wielded the hammer with strength, and with exquisite delicacy drew the finest lines of crystal figures; and from their work rest the eyes which saw the snowy summits of the Altai, and distinguished the "matt" and the "glänzend" on the surfaces of rock-crystals. Peace to his ashes! Blessed are the peacemakers!—*Am. Jour. Science.*[*]

ATHENÆUM SCRAPS.

A large mass of meteoric iron has been discovered, by Herr B. Schreibter, at Neuntmannsdörf, in Saxony. The iron contains 5·31 per cent. of nickel. This interesting specimen has been acquired by the Royal Mineralogical Museum in Dresden.

The conditions necessary for the formation of azurite, or blue carbonate of copper, have been carefully studied by Dr. Wibel, of Hamburg. His experiments show that azurite is formed from malachite, or the green carbonate, by abstraction of water, and addition of carbonic acid; a change which may be effected at ordinary temperatures, by the action of carbonic acid in the presence of a water-abstracting agent.

An improved method of gilding on iron and similar metals has been introduced by Herr W. Kirchmann. The surface of the metal, even when oxidized, may be prepared by treatment with sodium-amalgam; chloride of gold is then poured over the amalgamated surface, and, by application of heat, the mercury may be expelled, leaving an uniform film of gold capable of receiving a polish.

The supply of lithographic stone from Germany has been gradually falling off—hence it is important to notice the discovery of two sources of supply in Italy, one near the French frontier and the other on the coast of the Gulf of Genoa. It is said that the stones are of superior quality.

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[*] From the German of Prof. Vom Rath, of Bonn.

The *Bulletin de la Société Chimique de Paris*, amongst many chemical papers of much interest, draws some attention to a waterproof glue, which promises to be of considerable value. The action of light in rendering the size on paper, when it is coated with the bichromate of potassa, insoluble was first noticed by Mr. Mongo Ponton, and the principle has been applied to several of the photographic printing processes. Gum, glue or gelatine may thus be rendered insoluble, and the action takes place, though slowly, in the dark. A concentrated solution of the bichromate of potassa is kept in the dark, and some of it is added to boiled gelatine. Anything glued with this may, after a little time be washed with hot water without effect. A parchment paper, used for wrapping the pea-sausages of the German soldier, is prepared by M. J. Stinde with this chromatized gelatine.

During an unusually heavy snow-storm in Stockholm, which continued for five or six days in December, 1871, Nordenskjöld detected, even in those portions of the snow which fell latest, a black carbonaceous powder, charged with very small spangles of metallic iron. He has since found similar substances in the snows of the Arctic Regions and from the heart of Finland. It will be curious to learn from the analysis, which he has recently promised, whether the iron in this cosmical dust is similar to meteoric iron.

Attention has been called, by Prof. B. Silliman, to the probable occurrence of small diamonds in the sands left in the sluices of hydraulic washings in California. A microscopic examination of a sample of these sands, from Cherokee, in Butte County, revealed the existence of numerous crystals of hyacinth or zircon, associated with crystals of topaz, fragments of quartz, black grains of chromite and titanic iron-ore, and a few small masses of a highly refracting substance, which, from its physical and chemical characters, is believed to be true diamond. The occurrence of diamonds in California has long been known, although not under these circumstances.

THE

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NOTES ON A JOURNEY THROUGH THE NORTH-WEST TERRITORY, FROM MANITOBA TO ROCKY MOUNTAIN HOUSE.*

By A. R. C. Selwyn, F.G.S

Director of the Geological Survey of Canada.

Having during the past summer made a rapid journey through a very considerable portion of the north-western territories of the Dominion, I thought it would perhaps be interesting to the Society to hear a brief account of how we travelled, and what we met with in those distant and as yet but little explored regions. If in relating my experiences I should refer to matters with which doubtless many members are already familiar, either from personal experience or from having read the narratives of previous travellers in the same region, my excuse must be that without doing so, I should probably have little if anything to relate which has not been dwelt upon and described, either by Palliser, Hector, Blakiston, Bourgeau, Hind, Milton and Cheadle, Butler, Ross or Grant, and is consequently more or less known to all who have read the interesting and detailed narratives which have been published by these travellers in the north-west.

The explorer of these vast western regions, so appropriately designated by Captain Butler *The Great Lone Land*, leaves behind him hotels, railroads and stages, as well as all other ordinary facilities for travel. He is thrown entirely on his own resources; and therefore before starting has to provide himself with everything requisite for the subsistence, transport and shelter of himself and his companions during the entire journey.

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* Read before the Natural History Society, Jan. 26th, 1874.

The staple articles of food in general use by *voyageurs*, and hunters and travellers in the North West, are pemmican, flour, tea and sugar. Persons, like ourselves, starting from civilized life, generally provide themselves in addition with a moderate supply of pork, ham, or bacon, and a few other luxuries, and for some days, especially when prairie chickens or ducks are abundant, look with disdain, not to say disgust, upon the *richôt* and *rubeiboo*. After a few weeks, however, the feeling wears off, and pemmican, richôt and rubeiboo, varied by dried buffalo meat, boiled, are eaten not only without a murmur but with keen appetite, at breakfast, dinner and supper; and I have even seen these dishes selected in preference to roast duck or prairie chicken or fried pork, ham or bacon, by persons who, on starting, declared that nothing short of absolute starvation would ever induce them to make a meal on pemmican.

Captain Butler, who was evidently not an admirer of pemmican, thus describes it: "Pemmican, the favorite food of the Indian and the half-breed *voyageur*, can be made from the flesh of any animal, but it is nearly altogether composed of buffalo meat: the meat is first cut into slices, then dried either by fire or in the sun, and then pounded or beaten out into a thick flaky substance; in this state it is put into a large bag made from the hide of the animal, the dry pulp being soldered down into a hard, solid mass, by melted fat being poured over it—the quantity of fat is nearly half the total weight, forty pounds of fat going to fifty pounds of 'beat meat'; the best pemmican generally has added to it ten pounds of berries and sugar, the whole composition forming the most solid description of food that man can make. If any person should feel inclined to ask, 'What does pemmican taste like?' I can only reply 'Like pemmican.' There is nothing else in the world that bears to it the slightest resemblance. Can I say anything that will give an idea of its sufficing quality? yes, I think I can. A dog that will eat from four to six pounds of raw fish a day when sleighing, will only devour two pounds of pemmican, if he be fed upon that food; yet I have seen Indians and half-breeds eat four pounds of it in a single day. Pemmican can be prepared in many ways, and it is not easy to decide which method is the least objectionable. There is rubeiboo and richôt, and pemmican plain and pemmican raw, this last method being the one most in vogue amongst *voyageurs*, but the richôt, to me, seemed the best; mixed with a little flour and fried in a pan, pemmican in this form can be eaten, provided the appetite be sharp and there is nothing else to be had; this last consideration is however of importance."

I do not altogether agree with Capt. Butler in his estimate of pemmican, and for my own part, I never disliked it and could always make a hearty meal off it, and for voyaging it certainly has very great advantages not possessed by any other description of food.

The land transport of heavy goods, throughout the country westward from Red River to the Rocky Mountains, is effected with carts drawn by single horses or oxen. They usually carry from six to eight hundred pounds, or sometimes less, according to the length of the journey and the rate at which it is intended to travel; twenty to thirty miles is an average day's journey. These carts, known as Red River carts, are exceedingly rough and clumsy looking vehicles, with wheels 5½ to 6 feet in diameter. They are built entirely of wood, oak, ash and birch, and cost when new from fifteen to twenty dollars. Notwithstanding their appearance, however, they are, from the absence of iron in their construction, wonderfully light; this, together with the facility from the same cause with which they can be repaired, renders them very suitable for the country and for the work required of them. If an axle breaks or otherwise fails it can be quickly replaced: an oak or birch log of the required size, an axe, an auger and a drawing knife being all the tools and materials required for the purpose. From the rough character of some of the tracks, this accident is of such common occurence that when travelling on the prairie where no timber can be had, it is customary to carry suitable pieces of wood for replacing them slung to the side of each cart. Another advantage which these carts possess, is that with the aid of a waterproof tarpaulin or a buffalo hide they are readily converted into serviceable rafts, and are often used in this way for floating goods and passengers in safety over any unbridged, deep or swollen streams which have to be crossed. Besides the carts described, the light express waggon is gradually coming into use in the North West, but for expedition and comfort in crossing the plains, the buck-board is decidedly to be preferred to any other vehicle, and is much less fatiguing to both man and horse than the saddle. Connected with the means of transport I must not omit to say a few words about *Shaganappi*. Shaganappi is a most valuable institution, and must on no account be overlooked in the outfit of a prairie traveller. The word is Indian, and I believe really signifies line, rope or cord of any kind; it is, however, commonly used by voyageurs to designate dressed and smoked moose-skin, which on the plains serves for almost every purpose, for which, under ordinary circumstances, either string, cord, line, rope, nails, cloth or leather would be used. Hobbles, tether-ropes, whip-thongs, boot-laces, and moccassins are made of it; harness, saddles, bridles, carts, tents and clothes are repaired with it; and it may be regarded as the *sine qua non* of the voyageur, and only second in importance to pemmican itself.

The general use of the Red River cart for the inland transport is, I believe, only of comparatively recent date, and even now is confined to the open country bordering the great valleys of the two Saskatchewans, the Qu'Appelle and the Assiniboine Rivers. Beyond these limits, in the mountains where there are no navigable waters, and in the thick woods where there are no cart roads, everything is transported by pack animals. Formerly, before the opening up of the Red River and the Lake Superior routes, and when the whole trade of the country was carried on by the Hudson's Bay Company, imports and exports of all kinds were transported by water in canoes or boats via Hudson's Bay; the distributing and receiving depots being York for the western district, and Albany, Moose and Fort Rupert on James' Bay for the eastern districts.

The boats in general use on all the large inland waters for voyaging and freighting purposes are known as Hudson's Bay batteaux, full and half size. The full sized batteau is a staunch and commodious, though rather clumsy looking craft, of the following dimensions: keel, 30 ft; over all, 42 ft., giving an equal shear to both ends, which are sharp as in a whale-boat; beam, 9–9½ feet, with a depth amidships of about 3 feet. For river navigation they are steered by a long sweep-oar passed through a ring bolted to the side of the projecting upper end of the stern post, and are usually propelled by five, six or eight heavy pine oars. When under sail a rudder is shipped, and they are rigged with a large, nearly square lug-sail: they draw about two feet when loaded with from 2½ to 3 tons, besides crew and equipment. Before the wind, they sail well and easily, and when properly handled, going at a speed of from eight to ten miles an hour, seldom take in water, even in very heavy seas, such as are frequently encountered on Lake Winnipeg. Such boats are, of course, not adapted for beating against a head wind, and with a side wind also they make considerable lee-way. They are, however, admirably suited for the mixed river and lake navigation for which they are designed. The voyageurs, occasionaly Indians, but mostly either French, Scotch or English half-breeds, pull a long steady stroke, averaging 19 per minute, always rising from their seats at each stroke. Every 20-25 minutes they cease pulling, lay in their oars, and light their pipes. The smoke occupies from 8–10 minutes, and during the interval the boat either drifts with the current, or, in still water, comes to a stand. So regular is this practice that *the smoke* is used as a measure of distance, and the guide will often tell you it's so many smokes to any point, the distance to which you may have occasion to enquire about.

My expedition last summer, was performed, the outward journey by land and the homeward journey by water transport. And, all things considered, I have arrived at the conclusion that for exploration purposes the latter mode of travelling is to be preferred, as being the cheapest, the most expeditious and the most comfortable, as well as affording better opportunities for observation and for the collection and preservation of specimens.

On the afternoon of the 25th of July, all our preparations being completed, we left Fort Garry or Winnipeg, the capital of the Province of Manitoba, situated at the confluence of the Assiniboine and Red Rivers,—latitude 49° 52′ north, and longitude 96° 50′ west—and in 49 days, or on the 12th of September, I reached Rocky Mountain House, situated on the upper waters of the Saskatchewan—latitude 54°20′ north and longitude 115° 10′ west. According to the measurements of the route which I made by means of an odometer attached to the cart wheel, the distance travelled was 1,056 miles. Stoppages and detentions from various causes during the journey amounted to nine days in all, five days on which we did not move camp, and eight on which we travelled for only half the day. We therefore averaged $26\frac{1}{4}$ miles per day, to do which, without fresh horses and seldom travelling at more than a walk, necessitated early starting and late camping, so that we were rarely less than ten hours on the road. My own party consisted of six persons besides myself, two of whom were thoroughly experienced half-breed voyageurs who spoke English and French as well as the Chippeway and Cree Indian languages. Travelling with us as far as Edmonton were two English gentlemen and their servants, so that our whole party numbered eleven persons. For the transport of this party, together with all necessary—and some very unnecessary—baggage and supplies, we had seven Red River carts, three of them belonging to our fellow travellers, one buck-board and sixteen horses, or Red River ponies. These were used either for saddle or harness, as occasion required, and four or six of them were left to run loose, as spare horses, so that each horse, as a rule, would not be worked for more than half the day's journey, by which means, although travelling almost every day for eight, nine or ten hours, all the horses had time enough to feed and rest, and sore backs, sore shoulders and knocked-up horses, together with the delays and troubles so commonly resulting from these causes on a long journey, were entirely avoided.

During the whole journey we were favoured with remarkably fine weather. On the outward trip we were detained only one whole day by rain, and half a day only from the same cause on the homeward trip. We had a few wet nights, and snow fell on two or three days between the 11th and the 30th of September. The first frost was experienced on the 4th of September when the thermometer at 4 a.m. registered 28° Fahrenheit. On the 6th, at 6 a.m. it registered 26°. The next frost occurred on the 11th of September, the thermometer falling during the night to 20°; and on the 23d of September the thermometer again registered 12° degrees of frost. Thence forward, frosty nights were of pretty frequent occurrence, and on the 29th of October the steamboats on the Red River were all frozen in. These, as I was informed, unusually early frosts, injured many if not all of the wheat crops on the upper Saskatchewan, and also some of the potatoes that were still in the ground.

We met with no hair-breadth escapes, no startling incidents, and no accidents or casualties of any kind worth recording, nor did we experience any trouble or annoyance from the various parties of Indians we fell in with on the road. The only real trouble which we experienced was occasioned by mosquitoes and other flies, black-flies and sand-flies. I have seen and felt the annoying attacks of these pests in various parts of the world; the valleys of the Columbia and Fraser Rivers are noted for them, and I used to think they could not be much worse than they are in Australia and in various parts of Eastern Canada, but if any one desires to know what mosquitoes and black-flies really can be, I can only say cross the Saskatchewan plains in August. Even the sharp frosts of September, though they lessened the activity of the mosquitoes, had no apparent effect upon that of the black-flies; directly the sun rose, even though the ground was covered with snow, they were as virulent as in the hottest day in summer; and I was credibly informed that horses have frequently died from the result of their attacks; there is no doubt that they suffer frightfully from this cause, and if measures are not taken to protect them, rapidly become so poor and weak as to be unable to travel.

Not many years ago, the region we traversed was swarming with buffaloes; now their skulls whitening on the plain, and the deep worn and grass-grown tracks which traverse the prairies in all directions are the only evidence of their former existence. Not a single buffalo was seen during the journey, and very little large game of any kind,—only a few antelopes or *cabri,* one moose and one red deer. Foxes, wolves, badgers, skunks, minks and beavers were seen or heard occasionally. Muskrats are very abundant and swarm in the delta of the Saskatchewan. The officer in charge at Cumberland House informed me that he had last year collected and sent away 240,000 skins of these animals. On the prairies, the little gopher or ground squirrel is almost equally abundant. It is about the same size as the Canadian chipmunk, and its habits appear to be similar to those of the prairie-dog of the southern prairies. Like them, they live in colonies underground on the open treeless prairies, and are generally seen sitting erect and motionless on their hind quarters either perched on the hillocks or in the grass near their burrows into which they quickly disappear at the least alarm. Their skin is of no value, and, except foxes, they have few enemies to contend with in the 'struggle for life.' Moles, judging from the large earth-mounds thrown up by them over extensive areas, though we did not see any, must be almost as numerous as the gophers. The moles seem invariably to select the tracts of deep, rich, black soil, and the gophers and badgers the intervening dry, sandy and gravelly ridges, so that between them the greater part of the surface is more or less burrowed, ridged and furrowed; and where this is the case, the prairie, which would otherwise be as smooth and even as a lawn, becomes not only exceedingly rough and unpleasant to travel over on wheels, but also very dangerous to horsemen, and often fatal to the wooden cart axles.

Of feathered game we could always procure while on the plains as much as we required. From Red River to Rocky Mountain House, prairie chickens abound; ducks of various kinds swarm upon nearly all the lakes and pools, and geese are frequently seen, especially on the saline lakes. The geese are however not easily approached, and without a good dog to bring them out of the water, neither geese nor ducks when shot can be secured, except by wading through the broad belt of mud and high reeds by which nearly all the lakes are more or less encompassed. Cranes, bitterns, plovers, sand-pipers, snipe and other waders, as well as pigeons, black-birds, larks and a number of other small birds are plentiful on the prairies or in the swamps, or along the river valleys, and crows and several kinds of hawks are also very common. On our passage down the river in September and October, large flocks of wavy's, grey, and black and white geese, and of the large blue cranes, were frequently seen flying southward, generally at a great height; a few wild swans and pelicans were also seen passing in the same direction. Between Fort Pitt and to near the Elbow of the North Branch, a good many magpies were seen along the river, but none were observed elsewhere. I am told that these birds are very common on parts of the Qu'Appelle River and of the South Saskatchewan, but I believe they are not met with eastward of Red River. West of Cumberland or Pine Island Lake, where the Saskatchewan spreads out into a vast swampy delta, numbers of large white owls were observed sitting perfectly motionless, perched either on boulders or snags, or on some of the many small patches of bare sand just appearing above the level of the surrounding waste of water and swamp which was here seen stretching on all sides, as far as the eye could reach.

There are very few fishes of any description in the Saskatchewan above its confluence with the South Branch, but from Fort a la Corne downwards to Lake Winnipeg, sturgeon, white-fish and other excellent varieties are abundant. So far as I could ascertain there are no fishes at all in any of the numberless lakes and pools on the prairies between Red River and Carlton. West and north-west of Carlton and Edmonton, however, and in most of the lakes, many of them of large size, along the water-shed between the MacKenzie and the Saskatchewan, white-fish are said to abound. Jack Fish Lake and Lake St. Ann are two of these lakes in which they are annually caught in large numbers.

Many of the lakes which we passed between Fort Ellice and Carlton, especially some of those in the Touchwood Hills, seem to be as well suited for fish as others do where they abound, and the cause of their partial and irregular distribution in the country is not very apparent, though perhaps a careful investigation of the character of the waters in the different lakes would afford a satisfactory explanation of the circumstance. Westward from the summit of the ascent to the second prairie steppe of Palliser, the eastern slope of which forms the long range of low hills extending from the Pembina Mountains to the Basquia Hills near Cumberland House, and including the Riding, Duck and Porcupine Mountains, the country on the route which we travelled, especially after crossing the Assiniboine River at Fort Ellice, is generally undulating or rolling, and often hilly: some of the hills rise to from 200-300 feet, and occasionally to as much as 400 feet above the general level of the prairie, and afford from their summits extensive views of the surrounding country which everywhere presents a park-like aspect; belts, patches and clumps of woodland with intervening grassy meadows, or wide stretches of open prairie interspersed with countless lakes and pools, are seen on all sides, while the wonderful variety and beauty of the flowering plants, roses, lillies, gentians, lark-spur, a beautiful purple, aromatic mint like plant, buffalo-root, varieties of sunflowers and a host of others, lend an additional charm to the beauties of this picturesquely lovely landscape.

The ridges, which do not appear to maintain any constant direction or parallelism, as well as the hills, are all covered with drift sand and gravel, and scattered over them, resting on their flanks and summits, or partially imbedded in the soil, are numbers of angular ice-borne boulders or rock masses of enormous dimensions, consisting of limestone, granite, gneiss, mica schist and other metamorphic rocks. Absolutely level and open plains constitute but a small proportion of the total area of the region, while by far the larger part of it may be described as a vast billowy plain without either deep valleys or prominent hills. Besides the lakes which have streams constantly flowing out of them, and which all contain fresh water, there are others, far more numerous, holding water of almost every degree of saltness. Some of these saline lakes are as much as three, four or five miles in length and often from one to two miles wide. They occur either in isolated, irregular basin-shaped hollows, or forming chains of lakes in broad, flat, valley-like depressions, often extending many miles, but closed in on all sides by rounded, drift-covered hills with grassy slopes. When occurring in this manner, the lowest lake in the valley receives the drainage of the others, and I observed in all such cases, that while the water of the uppermost lake would be either quite fresh or only very slightly saline, that in the lowest lake of the chain would be intensely salt and bitter. This peculiarity may also often be observed as regards isolated lakes near each other situated at different altitudes, and the traveller seeking good water should always look for it in those pools or lakes which occupy the most elevated positions, because the water in them is supplied by rain and snow alone, and not by drainage and percolation from higher levels. All the old voyageurs and traders in the country state that good water was formerly much more plentiful on the prairies than it is now, and in the course of our journey numbers of places were pointed out to me as the sites of pools or lakes, formerly holding fresh water at all seasons, which are now only irregular shaped, flat-bottomed, dry depressions, clothed with a growth of long, coarse grass, and surrounded with a fringe of low willow bushes or banks of sand and gravel. This drying up of the country has been ascribed to various causes, but is generally supposed to be connected with the gradual destruction of the forests over large areas by fires. Whatever the effects may be of these destructive conflagrations in reference to the water supply of the region, there is no doubt that at different times almost every square mile of the country between Red River and the Rocky Mountains has been subjected to them, and that hundreds of miles of forest have thus been converted into wide and almost treeless expanses of prairie. And there is little room for doubting that the tendency of this would be to gradually diminish the rain fall.

The second and third prairie steppes, from Fort Ellice to Rocky Mountain House, may be said to be absolutely denuded of good timber. Between the Assiniboine and the English River, 120 miles west of Carlton, or for a total distance of 400 miles, neither oak, ash, elm, birch, spruce or pine trees were seen, and even the poplars are of small size, and suited for little else than firewood. Around the Little Touchwood Hills Fort, there is a small extent of forest, in which the largest poplar trees attain a diameter of two feet, and in the same district there are also some fair-sized white birch trees. On the English River, and thence westward, both along the banks of the Saskatchewan and of the northern tributaries, spruce, pine and tamarack of small size are tolerably abundant. Along the river, above Edmonton, large spruce timber is plentiful and is annually cut in considerable quantities, and floated down the river for the supply of the posts and settlements below, as far as Carlton.

The greatest extent of uniformly rich soil in all this vast region is certainly to be found on the first prairie steppe, which stretches in an almost level plain westward from Red River for about eighty miles to the base of the hills already mentioned as extending from Pembina, in a northerly direction to near Cumberland Lake on the Saskatchewan. Its lesser elevation, probably in no part exceeding 750 feet above sea-level, renders it still more favorable for the cultivation of wheat and other products liable to injury by early and late frosts. The general luxuriance of the vegetation, however, both on the second and third steppes, over many hundreds of miles, at heights varying from 1,500 to 2,500 feet, amply testifies to the exceeding richness and fertility of the soil. Even on the hills and ridges where for the most part somewhat lighter and shallower soil prevails, and which might not be well suited for cultivation, there is, with few exceptions, an abundant growth of the most nutritious grasses and herbs, on which all kinds of cattle thrive admirably; while in the low lying flats and swamp beds an abundant supply of the finest hay can readily be secured for winter fodder in case of need. At present there are very few cattle in the country, and it is customary to house them and feed them on hay during the winter, the prevailing belief being that they cannot otherwise survive. There is, however, every reason to believe that this is a mistake; and that if a hardy race of cattle, suitable to the climate, were introduced, they would speedily become acclimated, and not only be able to survive, but that they would thrive through the winter without the aid of artificial feeding and shelter; and if so, vast herds might soon be reared on these rich and boundless pastures, reanimating the now deserted feeding grounds of the buffalo, and not only becoming a source of large profit to the settler, but also affording a ready and cheap means of providing for the Indians, who are now frequently reduced to the verge of starvation, owing to the annually increasing scarcity of the buffalo, upon which they are at present entirely dependent.

I took some trouble to enquire into this subject, and though I found the prevalent belief to be as I have stated, yet I was informed of several instances of cattle having been lost in the fall, and, in every case, they had not only survived but had been recovered in excellent condition in the following spring.

Such facts speak for themselves: but in any case the question is one of such immense importance to the country, that it seems to me to be well deserving the consideration of the Government whether it would not be advisable to devote a sum of money for the purpose of practically and thoroughly testing it. The threatened and much dreaded Indian trouble in the North-West is, in reality, simply a question of food; and if this experiment proved successful, it would certainly be the easiest possible means which could be adopted to overcome it. Intoxicated or hungry Indians are dangerous animals, and in this respect they do not differ much from their more civilized white brethern. Remove the causes which produce the intoxication and the hunger, with which they are now periodically afflicted, and I venture to say that very little trouble would be experienced in dealing with the Indians. To convert the plain Indians into tillers of the soil might never be accomplished, but to induce them to undertake pastoral pursuits, would, I conceive, not be attended with similar difficulties. At all events, the experiment is worth a trial; and may, I think, be said to offer a fair probability of success, if carried out with intelligence and energy.

With the exception of the limited extent of land which is cultivated at the Hudson's Bay posts and at the various Mission stations, no cultivation has yet been undertaken on either of the higher prairie levels. We saw abundant proof, however, at Pitt, Victoria, Edmonton and Prince Albert, of the fitness of the soil and climate for the growth of cereals and of all kinds of vegetables which can be successfully grown elsewhere under similar conditions of elevation and climate. It would be impossible in any other part of the world to find finer barley, wheat, potatoes, turnips, carrots, onions and cabbages than those we saw growing at Victoria and at the St. Albert R. C. Mission station near Edmonton. Even at Rocky Mountain House, a hundred miles nearer the mountains, and according to my observataions 3,432 ft. above the sea, barley, potatoes, turnips and onions were being grown successfully, while on the farm of Mr. McKenzie, 62 miles west of Fort Garry, the crops, which included wheat, barley, oats, rye, peas, beans (French and broad), potatoes, onions, carrots, swedes, turnips, mangolds, cabbages and timothy grass, would, I believe, compare favourably with the best crops of the same description, grown on the highest cultivated farms in any part of Canada or even in Britain. The returns given me by Mr. McKenzie of the following crops were, per acre, wheat, 30-40 bushels, oats, 50 bushels, barley, 35-40 bushels, potatoes 300-400 bushels, turnips, 600-700, and peas, 20-25. Mr. McKenzie has 40 acres under cultivation, and no better or more practical illustration could be desired than is afforded by this farm, of what the soil of these magnificent prairie lands is capable of when cultivated with intelligence and enterprise.

I now propose to make some brief remarks in connection with the incidents of our homeward journey, and upon the facts which were observed relating to the general character of the valley of the Saskatchewan and to the geological features displayed along its course. The homeward journey or voyage, which, as I have already stated, was performed entirely by water, was commenced on the 13th September from Rocky Mountain House and terminated at Fort Garry on the 2nd of October. During this interval we accomplished about eleven hundred miles of river, and three hundred miles of lake navigation; from Rocky Mountain House to Carlton in a half-sized, and from Carlton to Fort Garry in a full-sized, Hudson Bay batteau. Between Edmonton and Carlton, a distance by the river of about 400 miles, our party consisted of only five persons besides myself, and as none of the party had ever before descended the river, we had to find our way as best we could through the dangers and difficulties of the navigation, consisting of intricate channels, sand banks, shoals and rapids, none of which are, however, of a very formidable nature. Four of the party worked at the oars, the fifth took the helm, and I acted as bowsman, and by noting the bearing and distances of every bend, succeeded in making a tolerably accurate plan of the course of the river, sketching it in my note book to scale as we went along. Sometimes we were tempted by the prospect of a more direct course, to leave the main channel, and in almost every instance were landed on shoals or sand-bars, obliging us to retrace our steps at the expense of much laborious pulling, and poling against the current. Notwithstanding these mishaps, however, we made a prosperous and tolerably rapid passage, reaching Carlton on the thirteenth day after our departure from Edmonton, and thus averaging considerably more than thirty miles per day, the time we were actually travelling being only eleven and a half days On arriving at Carlton, we found that a full-sized batteau, well equipped and manned by five experienced half breed and Indian voyageurs, had just arrived with '*pieces*', i. e. goods, from Cumberland House, and would be starting on the return voyage on the following afternoon. I at once arranged with Mr. Clarke, the Hudson's Bay officer in charge at Carlton, to allow our party to proceed down the river in the boat. The same boat, but with three different crews, subsequently carried us the whole way to Fort Garry, a distance by Lake Winnipeg and Red River of about eight hundred miles, and the termination of our journey, which by land and water had extended over about 2,400 miles, performed in eighty-two days of actual travel, or, including stoppages and detentions, in ninety-three days, without the aid of stages, steamboats or railroads.

Once during the voyage we narrowly escaped encountering an accident, which would certainly have been exceedingly unpleasant, and might even have endangered the lives of the party. This occurred during our traverse of Lake Winnipeg, on the evening of the 17th of October, when a violent gale overtook us while we were running for a group of islands far out on the lake. We did not succeed in reaching these till long after dark, and as they were quite unknown to any of our crew, the landing on them in safety in a dark night with a heavy gale blowing and a corresponding sea, became a somewhat difficult and hazardous undertaking; but it had to be attempted, so running between two of them we neared the shore of the one which looked most promising, and rounding a stony point on which the breakers were dashing with tremendous force, we fortunately succeeded in gaining a small sheltered cove with a sandy beach of only a few yards in extent. Had we missed this cove and been blown off the shore, we must almost certainly have gone upon the rocks, and our boat been dashed to pieces.

Starting from Rocky Mountain House, lat. 52° 20′ north, and long. 115° 10′ west, the North Saskatchewan River runs in a general north-easterly direction till it reaches a point about 90 miles below Edmonton in lat. 54° 10′ north, long. 111° 30′ west; it then sweeps gradually round to the south-east, on which course it runs with many minor bends, till it reaches "*The Elbow*," lat. 52° 20′ north, and longitude 107° west. At this point, as the name implies, a sharp bend occurs, again giving it a general north-easterly course, which it maintains to the vicinity of Cumberland Lake, where it a second time reaches the latitude of 54° north between the 101st and 103rd degrees of west longitude, thence a comparatively short south-easterly course of about one hundred miles, carries it to its mouth in Lake Winnipeg, while the three upper sections above described, have a nearly equal length of about 300 miles each. In this great distance of more than eleven hundred miles, as might be expected, the character of the country bordering the river exhibits considerable diversity. The most prominent features, however, may be summarised in the three words prairie, swamp, forest, and we may add vast, boundless, immense, illimitable, and yet scarcely convey an adequate idea of their greatness.

The rapidity with which we were obliged to travel through this vast region in order to escape being overtaken by winter was a matter which I regretted exceedingly, as no time was afforded for anything like minute investigation, or for the collection of specimens; and such notes as I was able to make upon the geology of the country are the result of observations of the most hurried description, and will probably add very little to the information which has already been supplied by the labours of Dr. Hector in his admirabie sketch of the geological structure of the region published in the Journal of the Geological Society (Vol. XVII–1861) and which is the result of observations extending over a period of nearly four years. I have already mentioned the prevalence of drift-covered hills and ridges, strewn with large, ice-borne boulders. From Fort Garry westward, on the route we travelled, no rock exposures were seen till within a few miles of Edmonton. An universal mantle of drift-sand, clay and gravel are spread over the face of the country but gradually diminishes in thickness towards the higher levels, though even where the drift is thin, the rocks are still concealed by a deep, rich, black soil. Without doubt, however, interesting exposures of the underlying strata might be found if sought for in the banks of some of the numerous creek valleys which we crossed between Carlton and Edmonton running from the high plain towards the river, but which, on the present occasion, we could not stop to examine.

In connection with the distribution of the materials forming the drift some noteworthy facts were observed. Blocks, and often enormous rock-masses of Silurian limestone holding characteristic fossils are widely and abundantly distributed over the first and second prairie steppes. The ascent to the third prarie level which has an average elevation of from 1,900-2000 ft. above the sea, commences at the Thickwood Hills, 20 miles west of Cartlon and on it the limestone boulders do not appear to have reached further west than the longitude of Fort Pitt, and between Pitt and Edmonton not a single boulder of limestone was observed either along the Saskatchewan River or on the plains. On the Saskatchewan above the the confluence of the Brazeau—a large tributary coming in from the west about mid way between Rocky Mountain House and Edmonton—there are no boulders, and very few pebbles of either granite gneiss or mica schist. At Rocky Mountain House the pebbles and boulders in the drift which is there seen in contact with the coal-bearing rocks, as well as those seen along the river bed are nearly all of either coal measure sandstone or conglomerate, or of varieties of hard quartzose and siliceous rocks, and though I searched carefully, I did not succeed in finding any of a granitoid or gneisic character. Small pebbles of grey and whitey-brown limestones holding fossils, but too fragmentary for determination, were also observed, but by far the larger proportion of the pebbles and boulders in the river at Rocky Mountain House, are composed of the hard siliceous rocks already mentioned, and many of these are traversed by cylindrical forms, having all the appearance of the *Scolithus* of the Potsdam sandstone formation. It may further be stated that along with the disappearance in ascending the river of the boulders of granitic, gneissic and micaceous rocks, the auriferous character of the drifts likewise dies out, and I was credibly informed that no gold could be found on the North Saskatchewan above Rocky Mountain House, though it had frequently been prospected for by experienced miners. The first gold washings which we saw in descending the river were rather more than forty miles below the mouth of the Brazeau, and thence to Edmonton, and for some miles further down, more or less gold has been found on the bars and in the river banks, but always in a very finely divided state, shewing evidence of having been transported from afar. Even as low down as Carlton, gold can, I believe, be found, though not in quantities sufficient to pay for working. On the South Saskatchewan, at the crossing place about twenty miles S.E. of Carlton, I washed out a few minute specks of gold from the gravel in the bed of the river, small red garnets and magnetic iron sand, constituting the bulk of the residue in the pannings. It would thus appear that the gold of she Saskatchewan has not been derived from the mountains at its source, but from the drifts composed of granitoid gneiss, or hornblendic and micaceous schist, which are spread over the face of the country, and which must themselves have been in a great part derived from the denudation of the great belt of Laurentian and other crystalline rocks which extends from Lake Superior, north-westerly to the Arctic sea. Numerous fragments and large pieces of silicified wood are frequently met with along the shore of the river, derived from the Tertiary and Cretaceous rocks. In the banks of Red Deer River, Dr. Hector observed a bed of this silicified wood in which there were silicified roots eighteen inches in diameter. I did not see any of it *in situ*, but loose specimens of these fossil woods have been collected by Mr. Bell, Mr. George Dawson and myself from widely separated regions, and it will be both interesting and important to know how far those from the North Saskatchewan correspond with those from the plains further to the south and with other recent and fossil woods from the western side of the Rocky Mountains.

Dr. Dawson has already examined and compared some of the specimens referred to, and will doubtless be able to give some interesting information about them, but larger and more perfect collections will be required. From the Rocky Mountain House to Edmonton, and thence to a short distance below Victoria there are numerous fair exposures of the strata at comparatively short intervals along the river; soft, friable, green, grey and brown, concretionary sandstones, alternating with blue and grey, arenaceous and argillaceous shales, and layers and beds of lignite and bright, jet like brown-coal are the prevailing features in these exposures. In the shales, there are layers of nodules, or septaria, of clay iron ore holding numerous fragments of plants and containing an average of 34.98 per cent. of iron. At one place on the right bank of the river, about 40 miles below the confluence of the Brazeau, I found a seam of this jet-like coal which measured from 18 to 20 feet thick, in two exposures, rather more than four miles apart. In the first exposure which extends some 50 or 60 yards in length, but which, owing to the swiftness of the current running at its base, is not easily examined, the seam is almost flat, and rises from the water in a nearly-vertical cliff, exposing eighteen feet of apparently excellent coal. The bottom of the seam here was beneath the water and could not be examined; above it, the cliff was not accessible and the rocks were concealed by slides of earth and other debris. The second exposure, which is no doubt a continuation of the same seam occurs in an arched form and shews eighteen feet of coal with one small, two to three inch parting of shale. The specimens collected were all taken from the surface, and it is not unlikely that beyond the influence of atmospheric action the coal in these seams will prove of better quality than is indicated by these specimens.

At intervals, the whole distance from Rocky Mountain House to Edmonton, 135 miles following the course of the river, and thence to Victoria, 76½ miles further down the river, similar rocks with coal seams and ironstone concretions, were observed. Dr. Hector has separated the Edmonton coal rocks from those which he saw at Rocky Mountain House by an intervening area which he considered to be occupied by a somewhat higher section or division of the Cretaceous series. He did not apparently see the thick seam of coal which I found, as already stated, below the Brazeau River, about eighty-six miles from Rocky Mountain House, and numerous indications of other seams which I saw, probably also escaped his notice, as he descended the river in the winter, when many of the exposures along the banks must have been concealed by snow. At present I am unable to say whether the seams retain their thicknesses for long distances, or whether the numerous exposures and indications seen in the cliffs along the river, represent only more or less lenticular shaped patches repeated at different horizons and over large areas. Dr. Hector appears to incline to the latter idea.

Below Victoria, the river valley widens considerably, and often rises by successive broad steps or terraces to the level of the prairies on either side; sometimes these terraces are quite bare, while at others they are pretty thickly clothed with small poplar trees, a few spruces and pines, and brushwood of willow, alder, and other shrubs. Occasionally the banks abut steeply upon the river, and afford imperfect exposures of the strata, which differ considerably from those met with at and above Victoria. Hard flaggy sandstones and impure limestones, associated with soft blue and gray clay, with layers of large concretions of olive-brown cement stones, or septaria, seamed by veins of yellowish calc-spar, and holding fossil shells (*Inoceramus*, &c.), are here met with, but without associated coal or lignite beds, or, so far as I observed, any plant remains. These are, I believe, a higher series, and overlie the great brown-coal and lignite formation seen on the upper portion of the river. Similar strata are then seen wherever sections occur the whole distance to the Elbow, about fifty miles above Carlton. Here (at the Elbow) the river leaves the eastern limit of the third or uppermost prairie level, formed by the Eagle Hills on the south, and by the Thickwood Hills on the north side of the valley, and making a sharp bend to the north-east, more or less parallel with the trend of the eastern slopes of the hills named, it flows across the second prairie level, making for the nearest point of its eastern limit, which it reaches about forty-five miles below Fort a la Corne. Between the Elbow and this point, and especially below Carlton, the immediate banks of the river are either low and flat, or rise in well-wooded slopes to the prairie level. In a few places, especially at Cole's Falls and for short distances both above and below Fort a la Corne, the valley closes in, and high cliffs rise steeply from the water's edge nearly to the prairie level. They are, however, all of drift, consisting of gravel underlaid by sand and clay, in which there are occasionally seen one or two layers of imbedded boulders of Silurian limestone, gneiss, and other rocks. The average level of the plains here, above the river, and at some distance back, does not probably exceed 300 feet. And according to my barometric observations, the river at Fort a la Corne is about 1172 feet above sea level, giving a fall between Carlton and Corne of about 172 feet in a distance by the river of 102 miles.

After leaving the eastern limit of the second prairie level, the river banks rarely rise to an elevation of fifty feet above the water, and the adjacent country is everywhere low and swampy and scarcely elevated at all above the flood level of the river, the marks of which were occasionally observed on the trees and bushes some eighteen inches or two feet above the surface which is formed of a deep, rich, alluvial silt. Similar low, swampy country everywhere intersected by water channels extends, with but few intervals to Cedar Lake, at the entrance to which ledges of the white, flat-lying Silurian limestones first make their appearance. Thence, to the mouth of the river, these limestones are either at the surface, or only thinly covered by soil or drift.

They are well exposed in vertical cliffs at the Grand Rapids, and they likewise occupy the whole of the western shores of Lake Winnipeg, extending in a south-easterly direction for 350 miles to Fort Garry. Some of the beds would, I think, afford good slabs for lithographic purposes, while from others a rich harvest of fossils awaits the collector. Between these limestones and the eastern slopes of the second prairie level, on the shores of Lake Winnipegosis and Manitoba, somewhat similar limestones have, I believe, been observed, holding fossils of Devonian age; so that we have in the great low-lying region which constitutes the first prairie level, a large part of which is occupied by the waters of lakes Winnipeg, Winnipegosis, and Manitoba, the eastern outcrops of a thick series of Devonian and Silurian strata, and it becomes an interesting question to determine how these eastern Palæozoic rocks are related to those of more disturbed and altered aspect which rise from beneath the coal-bearing Cretaceous formations at the sources of the Saskatchewan and there form the eastern slopes, as well as many of the higher summits of the Rocky Mountains. We know at present little or nothing respecting the total thickness of the Cretaceous rocks which are spread over a breadth of 1000 miles between Manitoba and the Rocky Mountains, neither do we at present know to what extent the upper part of the series, which is supposed to occupy the surface from the 100th meridian westward to about the 112th, may or may not be underlaid by the supposed older beds, with their associated seams of brown-coal and iron ore. The general scarcity and the poor quality of the timber over hundreds of miles of country, renders it, however, a matter of the very greatest importance in connection with the future settlement of a large portion of the "Fertile Belt," and with the opening it up either by land or by water steam transport, to ascertain where and at what depth beneath the surface coal could be procured which would be available for domestic purposes as well as for the supply of railroads and steamboats. Surface examination and survey alone, however minute, cannot be expected to lend much aid to the solution of this question, owing partly to the almost universal covering of superficial deposits, and partly also to the extreme flatness of the strata and the comparatively few points where they can be observed in natural exposures. It would, I think, not be difficult, however, to settle this point by means of a series of bore holes made at intervals along the valley of the Saskatchewan, between Carlton, Victoria, and Edmonton. The sites selected for these trials should be as near as possible to the level of the river, by which means the penetration of a considerable thickness of gravel, boulder drift, and sand, before reaching the cretaceous strata, would be avoided, and the trouble and expense would be proportionately diminished.

In conclusion, I may perhaps make a few remarks respecting the fitness of the Saskatchewan River for steamboat navigation, a subject which at the present moment is attracting considerable attention in connection with the establishing of a Canadian trans-continental route to British Columbia.

My journey down the Saskatchewan was performed between the 12th of September and the 17th of October, and therefore, in some respects, at a very unfavourable season to judge of the practicability of navigating it with steamboats. Throughout the whole length of the river, the channel is more or less subdivided by islands, and every sub-channel is further cut up and obstructed by sand-banks and shoals. Of course I saw them almost at their worst, as the water was everywhere from two to four feet lower than it would be at the opening of navigation in May or early in June. Nothing whatever can, I believe, be done that would obviate or lessen the constant formation and shifting of the shoals and sand-banks and the consequent annual changes in the position and depth of the main channel; a circumstance which must always render the navigation of the Saskatchewan above Fort a la Corne more or less subject to delays, and especially so towards the latter end of the season. For four months, however, under ordinary circumstances, no very serious obstacles would be encountered in the navigation of the river from above the Grand Rapid to Rocky Mountain House, by properly constructed steamboats. Moderate length, powerful engines, light draft, and as much strength as possible below the water line are essential points in the construction of any steamer which may be built for the navigation of the Saskatchewan. Last year, the Hudson's Bay Company built a steamboat intended to run from above the Grand Rapids to Edmonton, and her complete failure and loss on the Cross Lake Rapid may be ascribed almost entirely to want of attention to these requirements. She was far too long, and also too weak both in hull and machinery; and my impression, when I saw her lying a wreck on the bank of the river, was that the person who constructed her could never have travelled the route for which she was designed. Towing flat-boats or barges, as practiced on Red River would, I think, be impracticable on the Saskatchewan for the reasons that in many parts the current is too strong, while in others the available channel between the islands and sand-banks and shoals are too narrow and tortuous. The only really insurmountable obstruction to steam navigation from Fort Garry to Rocky Mountain House is the Grand Rapid. It appears to have been carefully measured and examined by Professor Hind, who states it to be 2¾ miles in length with a total fall of 43½ feet. Whether the outlay requisite for a canal and locks to surmount this would be repaid by the result, is a matter for consideration. Between the head of the Grand Rapid and the confluence of the two Saskatchewans, there are only two places where, especially during the latter part of the season when the water is low, steamboats might experience some difficulty and would possibly require to be warped against the current, these are the Cross Lake Rapids and Tobin's or Thobon's Rapid, the one between Cedar Lake and Grand Rapid and the other between Cumberland or Pine Island Lake and Fort à la Corne. Immediately above the confluence of the North and South Branches are the *Coal* or *Cole's Falls*. Next to the Grand Rapid these falls appear to me to constitute the most serious impediment to the navigation. They extend over a length, according to my estimate, of rather more than twelve miles. I am not able to say exactly what the total fall is, but my two barometers gave a difference of 0.44 and 0.45 respectively, between the junction and the upper end of the falls. This would indicate a fall in that distance of from 40–45 feet. The width of the river is from 150 to 170 or 200 yards, and the rapids vary in length from one hundred yards to about a quarter of a mile. The bed of the river is everywhere filled with large, rounded boulders of gneiss, granite and limestone, and when we passed, many of these were shewing above the water, while more were covered only a few inches deep. This was on the 4th of October, and then no steamboat could have passed either up or down with safety. Our boat, an ordinary Hudson's Bay batteau, drawing only about eighteen inches, touched the rocks several times, notwithstanding that we had a careful and experienced steersman, well acquainted with the deepest channel. With two or three feet more water in the river, of course the appearance of these rapids would be greatly altered, and as there is no solid rock, the danger and difficulty of their navigation might be greatly lessened, if not altogether obviated, by the removal of some of the large boulders, a work which might probably be effected at a comparatively small cost. The current on this peice of the river would, however, always be very heavy, and proper arrangements for warping boats up these rapids in case of necessity, should be made in advance.

There is another very important matter connected with the Saskatchewan navigation which would require careful consideration. I allude to the great scarcity and poor quality for steam purposes of the wood which could be procured on long stretches of the river above Carlton; indeed the whole distance between Carlton and Edmonton this difficulty would arise, and I question whether it would not be more economical to establish coaling stations which could be supplied from the thick seam above Edmonton, than to use either poplar or spruce wood, neither of them of much value for steam purposes, especially where constant full pressure would be necessary. The coal in the seams referred to is very favourably situated for working and shipment, and could be taken down stream at a comparatively small cost. The arrangements for the return of the empty barges up stream would be the principal item of expense. My impression at present is that the coal-bearing rocks which crop in the banks of the river from near Victoria upwards pass with their associated coal-seams and iron ores beneath the Cretaceous septaria clays which are observed in the vicinity of Fort Pitt and the Elbow, and it may be that boring along the river valley would reveal workable seams of coal at such a limited depth beneath the surface as would render them available even as low down as Carlton.

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TABLE OF HEIGHTHS AND DISTANCES, &c.,

ON THE SASKATCHEWAN RIVER, FROM ROCKY MOUNTAIN HOUSE TO LAKE WINNIPEG.

	Mean Barometer Readings. *Selwyn.*	Mean Barometer Readings. *Palliser & Hector.*	Difference.	Distance by the River, Stat. miles. *Selwyn.*	Distance by the River, Stat. miles. *Palliser & Hector, & Hind.*		Difference.	Height above sea-level. *Selwyn.*	Height above sea-level. *Palliser & Hector.*	Difference.	Rise and fall in feet. Total, and ℔ mile. *Selwyn.*	Rise and fall in feet. Total, and ℔ mile. *Palliser & Hector.*
					Rep't	Map.						
Rocky Mt. House..	26.536	26.515	0.021	....	....		......	3229	3195	34	1070 7.86 ℔ m	1107 5.20 ℔ m
to				136	211	135	+ 1 −75					
Edmonton	27.686	27.626	0.060		....		......	2159	2088	71		
to				62							177 2.85 ℔ m	
Victoria	27.826	......	......	191	251	205	−14 −60	1982				
to				129							190 1.47 ℔ m	
Fort Pitt...........	28.069	......	......		....		......	1792				
to				198	235	195	+ 3 −37				448 2.26 ℔ m	
Carlton House.....	28.565	28.555	......	....	....		......	1344	1321	23	1885 3.58 ℔ m	1874 3.65 ℔ m
to				102							172 1.67 ℔ m	
Fort a la Corne....	28.769	......	......	....	....		......	1172	......	....	2057 3.42 ℔ m	
to				153	*Hind.* 150	132	+ 3 + 21					
Cumberland House	no value owing to stormy weather.											
to				59		56						
The Pas Post and Mission												
to				106		102						
Grand Rapid Post.	......	......	......	......	....		......	629	......	....	543 1.86 ℔ m	
Lake Winnipeg....	......	......	......	945	1005	825	+120 − 60	......	......	....	2600 2.81 ℔ m	*

* Taking 925 miles the average of the three totals given.

REMARKS.—The distances given in Palliser's Report differ from the same measured on his map—both are given. the latter nearly correspond with mine. None of the distances given are from actual measurement.

LONGITUDES, LATITUDES AND MAGNETIC VARIATIONS,

From the Reports of *Palliser*, *Blakiston* and *Hind*.

	Longitude.	Latitude.	Var'n.	Year.	Var'n.	Year.	Var'n.	Year.
R. M. H.	115.10.45	52.22.06	27.08	1873	26.20	1857	.....	....
Edmonton (mean of four)....	113.23.22	53.30.59	26.05	1873	25.20	1858	24 19	1844
Pitt.........................	109.17.00	53.33.04	24.37	1873	.....	....	23.10	1844
Carlton.....................	106.20.00	52.52.30	.....	....	23.25	1857	22.55	1844
Fort a la Corne	104.30.00	53.27.00	22.30	1858	.....	....	.....	...
Cumberland.................	102.19.00	53.56.00	.....	....	....	....	19.16	1844
Fort Garry..................	96.52.27	49.52.06	.....	....	12.03	1857	.....	....
	96.54.41	49.53.18	.....	....	.....	....	.....	....

BOTANICAL AND GEOLOGICAL NOTES.

BY A. T. DRUMMOND.

OWL'S HEAD, LAKE MEMPHRAMAGOG.

The floras of the Canadian mountain summits have not as yet received much attention. This is largely due to the almost inaccessibility of the mountains of the Lower St. Lawrence, especially of the north shore, where a rich harvest of semi-Arctic vegetation may be expected. The opening of the Intercolonial Railway will give better access to those on the south shore, and will, it is to be hoped, lead some of our naturalists, who have the opportunities, to visit them.

The flora of Owl's Head, one of the outliers of the Green Mountain range, I refer to here, not because it includes any characteristic plants but because it may be regarded as a type of the vegetation of the lesser peaks throughout Ontario and Quebec. The base of the mountain on the eastern side is washed by the waters of Lake Memphramagog. Here, at a height of 756 feet above the sea level—an elevation greater than that of Lake Superior—is a fair representation of the general New England flora, and it recalled to memory excursions made years ago among the Thousand Islands of the St. Lawrence. Precipitous moss-grown rocks, their moist, tree-shaded sides tenanted here and there by tufts of little spleenworts (*Asplenium Trichomanes*, L.), rise from the water's edge; and on the numerous ledges in often scanty soil and thence up the mountain side, more or less everywhere found, are red, mountain and sugar maples interspersed with aspens, beech trees and spruce. In the lake here are some of our more common fresh water shells as *Anodonta cataracta*, Say, *Margaritana undulata*, Lea, *Unio complanatus*, Sol., *Sphærium sulcatum*, Lam., and *Paludina decisa*, Say. In the course of the ascent up the little valleys and glens through which the mountain path winds there is not much change in the aspect of the flora until the summit is reached. The woods of any eastern Ontario township would present much the same appearance. Even among the Lichens there is nothing to indicate the smallest change of elevation.

There is one peculiarity observable among these little organisms, the Lichens, worthy of a place here, and it is a peculiarity not confined to the mountain plants but equally conspicuous on the trees, rocks and old palings everywhere. Lichens seem to delight in a situation having a northerly aspect. Though no rule can be laid down, still this is so often observable that it becomes quite possible to in a general way judge of the direction of one's path. Frequently on some old palings, the more northerly side is quite encrusted with various species which on the opposite side are almost wanting, and here as elsewhere on the barks of trees, they will often be seen thickly grouped together on the northerly exposure and gradually becoming less prevalent on either side as the southern exposure is approached. Now, it is well known that the last forms of vegetation met with on the highest peaks of the Himalayas or which greet the traveller in Arctic lands are Lichens, and it would seem as if here, in a temperate climate, these little plants evince a longing for the cold and exposure which suits so well the species in the polar zones.

Another feature connected with Lichens is their economic value as sources of dyes, though this has lost much of its importance during recent years by the discovery of aniline dyes. The old Orchella Weeds of commerce which yield beautiful purple tints have not yet been found on the American coast of the Atlantic ,nor thus far have I found more than one species in Canada —*Parmelia Borreri*, Turn. which yields to ammonia a purple dye. This is a very common Lichen of wide-spread range on this continent and noticeable here on Owl's Head alike on rocks and on the beech trees. But there are other dye Lichens also here. Some of those crisp, blackish species, resembling bits of old cast away leather, attached by their centres to the sides of the rocks, yield beautiful red tints, as also does *Theloschistes parietinus*, Fr.. one of those very common but pretty yellow species everywhere observable alike on rock and tree and paling.

At 2000 ft. above the sea, the beech is still sometimes seen and even the bass-wood climbs as high. But climbing over the large angular blocks which, chaos-like, lie piled around the north-eastern side, an almost bare peak is reached, protruding as it were above the green of the foliage below. Here we are at a height of 2600 ft. above the ocean level, and, strange as it may seem, nearly one thousand feet above the level of the central parts of the continent. The botanist must be an enthusiast who is so taken up with his favourite science that he cannot spare a moment for what from this summit is presented—one of the grandest panoramic views we have in Canada. To the northward Orford, reputed to be one of our higher peaks, with its broad, irregular outline obscuring the view of the extensive country behind, looks like a gigantic boulder set up in relief against the horizon beyond. At its base as it seems, though some miles distant, is the lower end of Lake Memphramagog, which with its beautiful bays and inlets and the hills on either side, sloping here abruptly and there gently to its shores, seems from this height like a large pond, though it stretches a distance of thirty miles past Owl's Head southward into Vermont. To the eastward of Orford and reposing in the lap of the hills which skirt the Massiwippi Valley is Massiwippi Lake. From this point beyond Lake Memphramagog in the middle distance between its shores and the horizon, the eyes wander southward over a rolling country mottled with light and sombre green, indicative of fields and forest, past Stanstead, with hardly a break on the horizon beyond, until they meet the Green Hills which group themselves around Newport and which extend thence southward peak beyond peak until they are lost to the eye in the hazy distance. Far away in the background of the view here but their outline somewhat dimmed, is the group of summits which form the White Mountains of New Hampshire.

The flora of the summit of Owl's Head is confined to a few common species and these of inconspicuous size. Here where the summit is but a narrow peak, exposed on every side, the scantiness and small growth of the vegetation is to be attributed to the bleak winds which must at this height be constantly hurricaned across it, as well as to some extent to slides which have taken place, rather than to the altitude. There are no flowering plants here which we might not also find in almost any part of the Province of Quebec south of the St. Lawrence. Tadousac and River du Loup at the sea level have several boreal forms in abundance: here there is almost nothing to remind one of Arctic life. The only northern plants are Lichens. Encrusting the rocks is that little cosmopolite of the mountains and Arctic and Antarctic regions of the globe, *Buellia geographica*, Schaer., the Map Lichen, its yellowish hue made more conspicuous by the blackish fringe surrounding it: near at hand is another pretty yellow species *Cetraria juniperina*, *Ach*, var. *pinastri*, Fr., and growing beside both and contrasting strongly with its pitchy color is another northern Lichen, *Parmelia Stygia*, Ach., the Blackalslaf of the Swedish Hills.

ADDITIONS TO THE CANADIAN LICHEN FLORA.

In the number of this jonrnal for October, 1865, there was published a provisional list of the Lichens of Ontario and Quebec. This embraced every species then known to occur within these provinces. The nomenclature of Prof. Tuckerman's Synopsis, published in 1848, was necessarily followed as being the only accessible authority on American Lichens. The views of the author of the Synopsis are now, however, widely different—the result of long, patient investigation—and following the arrangement of his recent Genera Lichenum, the same provisional list published now would indicate many generic and specific changes. The additions now made to the list include a number which are interesting as being semi-Arctic in range. In determining many of these species, I am again indebted to the valued assistance of Prof. Tuckerman.

I trust that those who have the opportunities will pay special attention to the Lichens of the Lower St. Lawrence coasts, Newfoundland and Nova Scotia as, particularly there, new or interesting species may be expected.

Cetraria Fahlunensis, Schaer. Tadousac and Owl's Head, Lake Memphramagog.

Parmelia stygia, Ach. Tadousac.

Umbilicaria erosa, Hoffm. Tadousac.

U. hyperborea, Hoffm. Tadousac.

Peltigera malacea, Ach. Tadousac.

Pannaria nigra, Nyl.

Collema pycnocarpum, Nyl. Durham, P.Q.

C. flaccidum, Ach. Tadousac.

C. pulposum, Bernh.

C. furvum, Nyl.

Leptogium chloromelum, Nyl.

Lecanora Hageni, Ach. Ottawa. London.

L. molybdina, Schaer.—an Arctic plant hitherto only known from Greenland but now detected at Tadousac and more recently by Prof. Tuckerman at Mt. Desert on the coast of Maine.

L. cervina, Sommerf. vars *pruinosa* and *simplex*.

Rinodina ascociscana, Tuck. Bark of trees.

Pertusaria hymenia, Tuck. Syn.

Biatora sanguineo-atra, Tuck. Syn.

B. mixta, Fr.

B. hypnophila, Turn. Ottawa.

B. rubella, Rabenh. vars. *suffusa* and *Schweinitzii*. London.

B. atro-rufa (Dicks) Fr. On earth, Tadousac.

Lecidea fusco-atra, Ach. Tadousac.

L. sanguinaria, Ach. Tadousac.

Buellia albo-atra, Hoffm.

Calicium fuscipes, Tuck. This is a new species approaching C. subtile, Fr. but "larger and stouter and with larger spores. apothecia exactly turbinate-lentiform, the under side as well as the upper portion of the brown stipe as if thinly white-varnished." London. Only other locality thus far—oak rails, New Jersey.

Staurothele umbrina, Wahl. Limestone rocks, Kingston.

Trypethelium virens, Tuck.

Verrucaria muralis, Ach. Limestone, Kingston.

V. Nylanderi, Hepp. A limestone species from Kingston approaches this in character.

V. microbola, Tuck. Limestone rocks, Kingston. This is a provisionally new species, allied to *V. pyrenophora*, Ach. but with apothecia less than half the size. "Thallus of minute, rounded, olivaceous, becoming grayish, commonly discrete granules; spores ovoid 4-locular."

Pyrenula hyalospora, Nyl. London.

THE DISTRIBUTION OF SOME CANADIAN PLANTS, AN ARGUMENT FOR THE MARINE ORIGIN OF THE ERIE CLAYS.

I have long thought that some of the striking anomalies in the distribution of our native plants throw considerable light upon the origin of the Erie clays and their relations to the marine clays and sands of the Province of Quebec. These Erie clays underlie the Saugeen clays, but contain no fossils, and we have therefore to look to extraneous sources for information regarding their origin. On more than one occasion I have maintained that the sea shore plants now so widely scattered around the Great Lakes and elsewhere indicate an extensive inroad of the ocean, and that their original migration to the interior is clearly referable to post pliocene times subsequent to the glacial drift. The clays and sands succeeding the Erie clays are lacustrine, and the underlying glacial drift, whatever its origin may be, points to a period of cold too excessive for temperate vegetation. It is difficult, then, to resist the conclusion that the migration of these plants took place during the deposition of the Erie clays, and then judging from the characteristic habits of the plants and their range, and the distribution of the clays, that these clays are of marine origin. Circumstances also seem to favour the view that the Leda clays and Saxicava sands of the Ottawa and St. Lawrence valleys were deposited about the same time. Mr. C. H. Hitchcock of Hanover, N.H., thinks that "as Lake Superior is 638 feet above the ocean, and the maritime plants surround its shores, there is an argument for its submergence at least to the depth of its surface, and probably to the height of its terraces, so that we may add 330 feet to the altitude of the lake. This would give nearly 1000 feet, which corresponds well with the known height at which marine shells have been found in Arctic America, viz., one thousand feet on Cornwallis and Beechey Islands."

It seems most probable that the boreal and semi-Arctic plants of the Lake Superior coasts, migrated thither contemporaneously with or prior to the maritime plants. They are not now numerous, but are of a marked northern type. They are not distributed beyond the lake shores. It is only on the headlands which jut far into the lake, and on the islands and the coast where the bleak winds which sweep across and down the lake have full play, and where the broad deep expanse of water keeps the atmosphere cool and moist, that they are met with. A few miles inland, beyond Fort William, the vegetation is in almost as great profusion and is as rank as in the central districts of Ontario. Even at the heads of deep bays on the northern coast, though in a higher latitude, the plants are of a more temperate type than those of Thunder Cape and other promontories. Upon some headlands of the southern shores of the lake such boreal and semi-arctic plants as *Anemone parviflora*, Michx., *Saxifraga aizoides*, L., *Saxifraga aizoon*, Jacq., *Saxifraga tricuspidata*, Retz., *Polygonum viviparum*, L., *Empetrum nigrum*, Linn. and *Carex capillaris*, L., likewise occur, and though it may, perhaps, be argued with apparent reason that the presence of some of these may be due to the play of winds and currents from the northern and western sides of the lake, yet there are others of these semi-arctic plants which have not yet been seen on the upper coasts. Now if these northern species here form colonies isolated from their fellows to the far north, without present means of communication, in accounting for their occurrence we must revert to some prior age when the conditions of temperature were such as to facilitate their migration from higher latitudes. The fossil remains in the clays and sands overlying the Erie clays are of a temperate type and preclude the hypothesis that the connection took place during their deposition. The Leda clays on the Lower Ottawa, on the other hand, contain plants of a northern temperate range, leaving it strongly open to probability that in the higher latitude of the country to the immediate northward of Lake Superior there was during the early periods of the deposits of these clays a temperature congenial to the growth of boreal plants. Nor is this probability dispelled by the hypothesis that the sea shore species were driven inland relatively about the same time, as, with the exception of *Cirsium horridulum*, Michx., a perhaps doubtfully maritime plant, and *Rumex maritimus*, L., which also occurs in the interior, all of those which are now distributed around the Great Lakes range high on the North Atlantic coast, mingling with semi-Arctic species on the shores of the River and Gulf of St. Lawrence, and on the Nova Scotian coast.

If the hypothesis which I have here ventured be correct, it is interesting thus to find that the Alpine flora of the White Hills of New England, the boreal colonies of the headlands of Lake Superior, the sea-shore plants now spread around the Great Lakes, and the fossil plants of the Leda clays, have all a contemporaneous origin; and that, considering the present normal range of these species on this continent, the wide distribution of some of them over Northern Europe, and the associations suggested by their exceptional locality and habits here, we obain a slight glimpse at the pre-historic record of existing species.

inted March 22nd, 1874.

OCCURRENCE OF GIGANTIC CUTTLE-FISHES ON THE COAST OF NEWFOUNDLAND.

By A. E. Verrill.

Considerable popular interest has been excited by several articles that have recently been published and extensively circulated in the newspapers of Canada and the United States, in regard to the appearance of gigantic "squids" on the Newfoundland coast. Having been so fortunate as to have obtained, through the kindness of Prof. S. F. Baird, the jaws and other parts of two of these creatures, and through the courtesy of Dr. J. W. Dawson, photographs of portions of two other specimens, I have thought it worth while to bring together, at this time, the main facts respecting the several specimens that have been seen or captured recently, so far as I have been able to collate them, reserving for a future article the full descriptions and figures of the jaws and other portions, now in my possession.

We now have reliable information concerning five different examples of these monsters that have appeared within a short period, at Newfoundland. (1). A specimen found floating at the surface, at the Grand Banks, in October, 1871, by Captain Campbell, of the schooner B. D. Haskins, of Gloucester, Mass. It was taken on board and part of it used for bait. Dr. A. S. Packard has given, in the American Naturalist, vol. vii, p. 91, Feb., 1873, all the facts that have been published in regard to this individual. But its jaws have since been sent to the Smithsonian Institution, and are now in my hands to be described and figured. They were thought by Professor Steenstrup, who saw a photograph of them, to belong to his *Architeuthis monachus*, which inhabits the northern coasts of Europe, but is still very imperfectly known. The horny jaw or beak from this specimen is thick and strong, nearly black; it is acute at the apex, with a decided notch or angle on the inside, about ·75 of an inch from the point, and beyond the notch is a large prominent angular lobe. The body of the specimen from which this jaw was taken is stated to have measured 15 feet in length and 4 feet 8 inches in circumference. The arms were mutilated, but the portions remaining were estimated to be 9 or 10 feet long, and 22 inches in circumference, two being shorter than the rest. It was estimated to weigh 2000 pounds.

(2.) A large individual attacked two men, who were in a small boat, in Conception Bay, and two of the arms which it threw across the boat were cut off with a hatchet, and brought ashore. Full accounts of this adventure, written by Mr. M. Harvey, have been published in many of the newspapers.* One of the severed arms, or a part of it, was preserved in the museum at St. John, and a photograph of it is now before me. This fragment represents the distal half of one of the long tentacular-arms, with its expanded terminal portion covered with suckers, 24 of which are larger, in two rows, with the border not serrate, but 1·25 inch in diameter; the others are smaller, very numerous, with the edge supported by a serrated calcareous ring. The part of the arm preserved measured 19 feet in length, and 3·5 inches in circumference, but wider, "like an oar," and 6 inches in circumference, nearer the end where the suckers are situated; but its length, when entire, was estimated at 42 feet.† The other arm was destroyed and no description was made, but it was said to have been 6 feet long and 10 inches in diameter; it was evidently one of the eight shorter sessile arms. The estimate given for the length of the "body" of this creature (60 feet) was probably intended for the *entire length*, including the arms.

(3.) A specimen was found alive in shallow water, at Coomb's Cove, and captured. Concerning this one I have seen only newspaper accounts. It is stated that its body measured ten feet in length and was "nearly as large round as a hogshead" (10 to 12 feet); its two long arms (of which only one remained) were forty-two feet in length, and "as large as a man's wrist;" its short arms were six feet in length, but about nine inches in diameter, "very stout and strong;" the suckers had a serrated edge. The color was reddish. The loss of one long arm and the correspondence of the other in size to the one amputated from from No. 2, justifies a suspicion that this was actually the same individual that attacked the boat. But if not, it was probably one of the same species, and of about the same size.

(4.) A pair of jaws and two of the suckers were recently forwarded to me from the Smithsonian Institution. These were received from Rev. A. Munn, who writes that they were taken from a specimen that came ashore at Bonavista Bay; that it measured thirty-two feet in length (probably the entire length, including more or less of the arms); and about six feet in circumference. This jaw is large and broad, but much thinner than that of No. 1, and without the deep notch and angular lobe seen in that specimen. It probably belongs to the *Architeuthis dux* of Steenstrup, or at least to the same species as the jaw figured by Dr. Packard.

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*Also in the Annals and Magazine of Natural History, January, 1874, with a wood-cut of the arm.

† Doubtless these long arms are very contractile and changeable in length like those of the ordinary squids.

(5). A smaller specimen, captured in December, in Logic Bay, about three miles from St. John, in herring nets. Of this I have a description in a letter to Dr. Dawson, from M. Harvey, Esq., who has also published a brief account of it in the "Morning Chronicle," of St. John. The letter is acompanied by two photographs of the specimen: one showing the entire body, somewhat mutilated anteriorly; the other showing the head with the ten arms attached. The body of this specimen was over seven feet long, and between five and six feet in circumference; the caudal fin was twenty-two inches broad, but short, thick, and emarginate posteriorly on each side, the end of the body being acute; the two long tentacular-arms were twenty-four feet in length, and two and a half inches in circumference, except at the broader part near the end; the tips slender and acute; the largest suckers 1·25 inch in diameter, with serrated edges; the eight short arms were each six feet long; the two largest were ten inches in circumference at base; the others were 9, 8 and 7 inches. These short arms taper to slender acute tips, and each bears about 100 large, bell-shaped suckers, with serrated margins. Each of the long arms bears, about 160 suckers on the broad terminal portion, all of which are denticulated; the largest ones, which form two regular alternating rows, of twelve each, are about an inch in diameter. There is also an outer row of much smaller suckers, alternating with the large ones, on each margin; the terminal part of these arms is thickly covered with small suckers: and numerous similar small suckers are crowded on that portion of the arms where the enlargement begins, before the commencement of the rows of large suckers. The arrangement of the suckers is nearly the same as on the long arm of No. 2, but in the latter the terminal portion of the arm, beyond the large suckers, as shown in the photographs, is not so long, tapering, and acute, but this may be due to the different conditions of the two specimens. It is probable that this was a young specimen of the same species as No. 2.

From the facts known at present, it appears probable that all these specimens, and several others that have been reported at various times from the same region, are referable to two species; one (probably *Architeuthis monachus*) represented only by the first of those enumerated above, and having a more elongated form of body and stouter jaws; the second (probably *A. dux*) represented by Nos. 2 to 5, above described, having a short, thick, massive body, and broad, but comparatively thin jaws, which are also different in form. Some of the differences in size and proportions, and in the suckers, observed among the four specimens referred to the latter species, may be due to sex, for the sexes differ considerably in these characters in all known cuttle-fishes.—*American Journal of Science.*

THE LATE ROBERT McANDREW, Esq., F.R.S., F.L.S., F.Z.S., &c.

In these days, when dredging operations are common, and their results carefully tabulated and easily accessible, it is instructive to remember that when some of us were boys even the most frequented seas had not been explored except by fishermen, and the geographical distribution of species had not been studied. Foremost in the ranks of new discoverers were the late Prof. Edward Forbes and his friend Mr. M'Andrew. The latter gentleman was of Scotch parentage, but born in England in 1802. He spent the first 27 years of his active life in Liverpool, and the remainder at Isleworth House, Middlesex, where he died after a brief illness last May. He was one of the largest wholesale fruit merchants, and it was "accident" that led him to devote his spare time to scientific pursuits. His wife having amused herself at the seaside by picking up all the cowries (*Trivia Europæa*) she could find, he suggested to her that it would be far better to see how many different kinds she could pick up. The variety surprised him. He began to collect shells, about the time that Deshayes was editing Lamarck's Animaux sans Vertèbres. Then he began to dredge, as the oystermen did, in an open boat. But when the results of his researches began to attract the attention of scientific men, he fitted out a yacht with what were then unheard of conveniences. Fixed to the out-side were frames for the fine sieve, and the coarse within. His trained sailors managed the dredge, threw the haul into the sieves, drenched the contents, and the sieves were brought in to be examined in comfort. The soft parts of the mollusks were gobbled by the poultry, which formed an integral portion of the establishment. In those days governments paid nothing for marine scientific explorations, and even the doles of £5 or £10 granted by the British Association had not begun. Naturalists are generally too poor to hire the necessary outfit; and an invitation to join a dredging party in Mr. M'Andrew's yacht was a rare treat. How seldom do wealthy commercial gentlemen confer such favors on working naturalists. All honor to the foremost in this noble aristocracy! With the results chiefly of Mr. M'Andrew's explorations, Prof. Forbes developed his theory of geographical distribution, founded, however, on what we now know to have been but partial data. The importance of the investigations was quickly perceived and the knowledge gained was systematized in the "History of British Mollusca" by Forbes and Hanley; a work which has formed a model for all subsequent accounts of local faunas, and the value of which has been by no means lessened by the recent volumes on the same subject by Mr. J. G. Jeffreys.

After fully exploring the different sub-faunæ of the British seas, a work which the late Mr. Barlee continued for Mr. Jeffreys' benefit, Mr. M'Andrew pursued his researches on the coasts of Spain and Portugal, the Levant, north coast of Africa, and the Western Islands, especially the Madeira group. Here he dredged in deeper water than had ever been before attempted. Among the many new species which he discovered, none were more interesting than the recent *Bifrontia*, till then only known as a fossil. During this period, Prof. Forbes made his researches in the Egean sea.

The temperate and subtropical portions of the Atlantic fauna having been thus carefully worked-out, Mr. M'Andrew directed his yacht to the Nothern Ocean, dredging among the fiords of Norway as far as the North Cape. The shells of this region have proved very valuable to us, as illustrating those of our own Gulf. In these expeditions, the late S. P. Woodward, Barrett, and other celebrated naturalists were invited to take their share.

For the first time then in the history of science, a merchant was found who, without training in college, and without any assistance, explored the whole fauna of the North Atlantic from the icy to the sub-tropical seas. This having been accomplished, Mr. M'Andrew sold his yacht, gave up his active share in busi ness, and devoted himself to the arrangement and distribution of his great collections.

Having, however, taken a pleasure-tour in the Holy Land and Egypt, he was struck by the surpassing richness of the shores at Suez; and returned, resolved to fit out another expedition to explore that Gulf, the furthest northern and western nook of the great Indo-Pacific fauna. This, the last labour of his life, was happily accomplished, and gained for him the gold medal of the French Academy in 1870.

Throughout his life, he was remarkable for his extreme modesty. He declined to describe his own species; and, as an author, contented himself with brief papers and reports in the transactions of the British Association, the Philosophical Society of Liverpool, the Annals of Natural History, &c. He generously distributed the riches he had acquired, to the British Museum, to those of Edinburgh University, Harvard College, Mass., the Smithsonian Institution, and to various other public and private collections. Only a week before his death, he made up an additional parcel for the British Museum. To this he had presented the fullest possible series, including some unique specimens, on the express condition that a catalogue of them should be published. This condition is still however unfulfilled.

To the collection now the property of McGill College, he presented not only a fine series from all of his Atlantic dredgings and those of the Red Sea, but also from his general duplicates. His last donation, received only a few weeks before his death, was a share of type E. Indian collections of Benson, which he had lately purchased.

Mr. M'Andrew's own collection was invaluable to the student from the accuracy and beauty of the arrangement, and the very full suites of all ages, varieties and localties, selected from the myriads which had passed through his hands. Some time ago he made exact conditions with the University of Cambridge, (Eng.), in accordance with which it has become their property, and will be preserved intact for the use of students.

Would that some portion of his spirit might descend on this side of the Atlantic; and that some of our "merchant princes" would adorn their calling, as he did, with the generous prosecution of scientific research; as well as with the strict integrity, the unostentatious charity, and the earnest perseverance of the Christian gentleman! P. P. C.

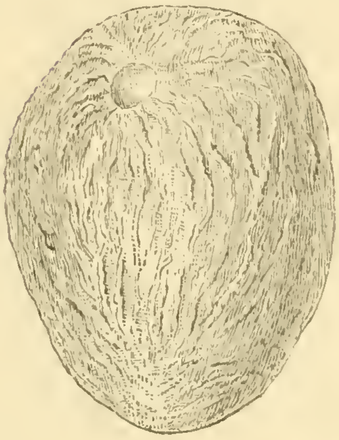
Montreal, Nov. 2nd, 1873.

ON SOME NEW OR LITTLE KNOWN FOSSILS FROM THE SILURIAN AND DEVONIAN ROCKS OF ONTARIO.

By E. Billings, F.G.S.

SILURIAN.

1



2

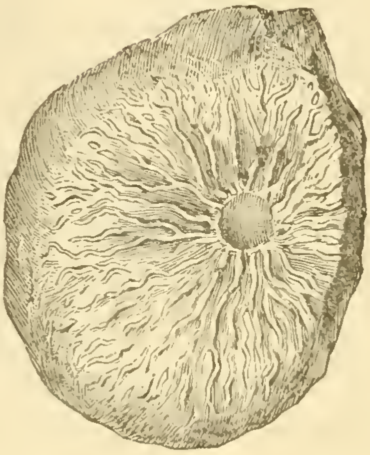


Fig. 1.—*Aulocopina Granti.*—A nearly perfect specimen.
" 2.—The summit of a larger specimen.

(Both figures natural size. The true characters of the surface cannot be perfectly represented by wood engravings.)

Genus Aulocopina (N. G.)

In a box of fossils lately sent to the Geological Survey by Major Grant, of Hamilton, there are several specimens which appear to me to belong to a new genus of sponges. The most perfect is of an elongate, ovate, or pyriform shape. The larger, or upper extremity, is more or less concave, with a small circular space in the centre, which appears to be the mouth of a tubular cavity that penetrated inwards and downwards, along the vertical axis of the sponge. I shall call it the "osculum." From its edges numerous small, irregular, sometimes branching ridges, radiate outwards in all directions over the surface, and descend the sides to the base. Several polished sections, through the osculum, downwards, show that the centre, at least in the upper half, was occupied by a large tubular canal, with smaller ones branching from its sides, outwards and downwards. This structure is only indicated by the dark colour of the material which fills the canals, in contrast with the light grey chert, which constitutes the mass of the fossil.

This genus somewhat resembles *Aulocopium* in its structure, but differs in having its whole surface covered with the rounded irregular ridges above mentioned. I propose to call it *Aulocopina*, and shall, hereafter, with additional material, endeavour to give a more detailed account of it.

I shall dedicate the only species known to me, to its discoverer, Major Chas. Coote Grant, H. P. 16th Regt. Foot.

1. A. Granti.—One of the specimens is 16 lines in length and 12 lines in width about the middle. The osculum is a little over two lines in width. There are in general from 5 to 9 striæ or ridges on its surface in the width of 3 lines. These radiate from the osculum and continue down to the base. so that the whole surface is covered with them. The specimen is somewhat compressed, so that a transverse section through the mid-length would be a somewhat irregular ellipse, the greater axis 12 lines, as given above, and the lower 9 lines.

The second specimen is also somewhat compressed, and is elongate-ovate, proportionately more slender than the former. Length 14 lines; greater diameter at the middle 8 lines; lesser diameter 6 lines; diameter of the osculum 2 lines. There are 6 to 8 striæ in the width of 3 lines, and they cover the whole surface.

The third specimen shows only the summit of a large individual. The diameter is 14 lines; width of the osculum 2 lines; there are from 6 to 8 ridges in the width of 3 lines. The central portion is concave, the osculum being situated in the bottom of the concavity.

A fourth specimen, a fragment, has a diameter of 2 inches at the summit; the osculum 4 lines wide.

Occurs in the Niagara formation at Hamilton.

DEVONIAN.

The Devonian fossils, described in this paper, having been all collected within a limited area in Ontario, I shall not give the localities after each species, but only mention here that all the Corniferous species are from the Counties of Haldimand, Welland, and Oxford. The species of the Hamilton formation are from the Township of Bosanquet.

The internal structure of the corals, was ascertained principally from polished sections, skillfully prepared by Mr. T. C. Weston, the Lapidary of the Survey.

Genus AMPLEXUS.

2. A. EXILIS.—Corallum more or less curved, expanding to a diameter of 14 lines at 3½ inches from the base. Surface with very distinctly defined costal striæ, of which there are 5 in the width of 3 lines, where the diameter is about one inch, and 6 or 7 in the same space at the base. There are about 64 septa where the diameter is 14 lines. The larger of these are scarcely a line in depth; the smaller about half that size. The tabulæ are very thin, flat or slightly undulating, distant from each other from 1 to 6 lines.

Owing to the fragile character of the shell, good specimens of this species are rare. The best in our collection consists of the lower 6 inches partly imbedded in the rock. By the application of acid, the whole of the interior has been completely freed from the limestone which filled it, so that it shows the tabulæ and septa perfectly. It is curved, somewhat irregularly, to a radius of between 4 and 5 inches. There are numerous small rings of growth, in general not very prominent, but with some that are angular and strongly elevated. These are, sometimes, so deep that they give to the costal striæ. a nodose appearance.

The extremely rudimentary state of the septa, distinguishes this species from all the described American forms known to me.

Occurs in the Corniferous.

3. A. MIRABILIS.—Corallum sometimes abruptly curved in different directions, expanding to a width of from 15 to 20 lines in a length of 4 or 5 inches from the base; above which it becomes more nearly cylindrical. Surface with fine engirdling striæ, in general 4 or 5 in the width of 2 lines, but in some places, the same number occur in the width of one line. There are also numerous angular rings of growth, distant from 2 to 15 lines from each other, with sub-concave spaces between. Septal costæ rounded, distinctly defined by sharp striæ between them, 7 or 8 in the width of 3 lines near the base, and 4 or 5 in the same near the calice. There are about 40 large septa at the calice, where the diameter is about 18 lines, with the same number of small ones between them. The larger have a depth of 3 or 4 lines and the smaller 1 line. All of the septa are more or less curved, sometimes very tortuous. The tabulæ have not been observed.

The above description was drawn up from a specimen, 11 inches in length, measured along all the curves. It is 15 lines in diameter at 5 inches from the base, and about 18 lines at the cup. The septal costæ are very distinctly defined at the base but become more flattened and obscure upwards. In external characters it resembles *A. exilis*, but the much greater developement of the septa distinguishes it therefrom.

To *A. mirabilis*, I add, provisionally, a specimen which when perfect, must have been 2 feet in length. It is 17 lines in diameter at the calice and about 11 lines at 12 inches below There are about 45 large septa at the base of the cup, with an equal number of smaller ones. Depth of the larger, 3 to 5 lines, and of the smaller, 1 or 2 lines. As in the former specimen all the septa are more or less curved.

Both specimens occur in the Corniferous.

Genus ZAPHRENTIS.

4. Z. INVENUSTA.—Corallum somewhat slender, expanding to a diameter of 16 lines in a length of 7 inches. Surface with numerous rounded rings of growth, of all sizes up to 3 lines in width. Costal striæ about 8 in the width of 3 lines, where the diameter is 10 or 12 lines. Where the diameter is 15 lines there are about 50 large and the same number of small septa. The larger have a depth of about 5 lines and the smaller 4 lines. They seem all to be slightly flexuous at their inner edges. The cup is about 1 inch in depth, the bottom smooth, flat or slightly concave and 4 lines wide. There is a small septal fossette. Occurs in the Corniferous.

5. Z. ERIPHYLE.—Corallum turbinate, slightly curved, expanding to a width of 2 inches in a length of about 4 inches. Surface with numerous small, mostly sharp-edged rings of growth. Near the base there are 7 or 8 costal striæ in the width of 3 lines; near the calice there appear to be 4 or 5. There are about 60 large septa, at a diameter of 2 inches. Many of these extend inwards to the centre. There are also 60 small septa, of a depth of from 5 to 7 lines. Bottom of the cup nearly flat, about 10 lines wide. The septal fossette is of an ovate form, its outer edge not reaching the margin, its inner extremity about half way to the centre.

This species is allied to *Z. invenusta* in having about the same numbers of septa in the same width. It differs in having a much greater diameter, and the large septa reaching the centre. Occurs in the Corniferous.

6. Z. Hecuba.—Corallum large. expanding to a diameter of 2½ inches in a length of 4 inches. Surface with numerous, slightly elevated, rings of growth. Costal striæ at the margin of the calice about 1 line wide; 5 or 6 in a width of 3 lines at the base. Where the diameter is 28 lines, there are 50 large septa, many of which reach the centre. Between these there are 50 smaller septa of about 1 line in depth. The calice in a specimen 5½ inches in length, measured along the convex curve, is 20 lines deep. The wall is very thin, all the septa reaching the margin, on approaching which, they all become of nearly the same size, and reduced to thin elevated ridges, less than a line in heighth, with concave grooves between them. The bottom of the cup occupies about half the whole width, nearly flat, the septa forming small elevated lines upon its surface, converging to the centre. The fossette is large and has three septa in it; one large and two small. This species resembles the last, but differs therefrom in being a larger form, with the rudimentary septa less developed. There is also a strong likeness between it and *Z. Stokesi*. Corniferous.

7. Z. Egeria.—Corallum, often strongly curved for 2 or 3 inches at the base, becoming more nearly straight above; expanding to a width of from 18 to 26 lines in a length of 4 or 5 inches. Surface with numerous rings, and a few undulations of growth. Epitheca thin, with 8 or 10 costal striæ in a width of 3 lines near the base; about half that number in the same space in the upper part of the coral.

In one specimen, in a transverse polished section, 3 inches from the base; there are 64 large septa 3 or four lines in depth, and the same number of small ones between 1 and 2 lines in depth. The diameter of the coral is here 18 lines.

In another individual, there is the same number of septa as in the former, the larger 5 or 6 lines in depth and the smaller from 2 to 4 lines. The diameter of this section is 25 lines and was cut across the coral at 4½ inches from the base.

A silicified specimen, 6 inches in length, shows that the cup is over an inch in depth, and the tabulæ excessively thin and fragile.

This is a more slender species than *Z. Hecuba*. It differs further in having more numerous septa at the same diameter and the large ones not reaching the centre except apparently near the base. It occurs in the Corniferous.

8. Z. GENITIVA.—Corallum turbinate, curved, expanding to a width of 21 lines in a length of 4½ inches. Surface with a few rounded folds of growth. Septal striæ 8 or 9 in the width of 3 lines at the base; in the upper part where the surface is perfect the striæ are not visible (in the specimen examined), but where a little worn there are about 6 in 3 lines, indicating both the large and small septa; or 3 where only the large septa are represented. At a diameter of 18 lines there are 56 large septa, 6 or 7 lines in depth; some of them reach nearly to the centre. The small septa are two or three lines in depth. The bottom of the cup is smooth with a slightly elevated, low pyramidal columella, forming a low ridge in the direction of a line drawn through the fossette. The latter is large, ovate, the smaller extremity pointing outwards. Occurs in the Corniferous.

9. Z. SUBRECTA.—Corallum somewhat straight, flexuous, gradually expanding to a diameter of 21 lines in a length of 6 inches. Surface with rounded folds of growth and a few broad undulations. Septal striæ 9 in the width of 3 lines at the base, becoming wider and more indistinct upwards. There are 38 large septa at a diameter of 18 lines, from 3 to 5 lines in depth; small septa, in general from ¼ to 1 line in depth. Occurs in the Corniferous.

Genus HETEROPHRENTIS (N. G.)

Corallum simple, turbinate. Calice large with a well defined septal fossette, the bottom either smooth or with a pseudocolumella.* Septa below the calice sharp-edged, often with their inner edges twisted together; above the floor of the calice they are usually rounded, especially on approaching the margin. There is apparently only a single transverse diaphragm, and this forms the floor of the cup.

This genus is intended to include (more especially) such species as *H. spatiosa*, *H. excellens* and some of those referred to *H. prolifica* = (*Zaphrentis prolifica*).

10. H. SPATIOSA.—This species I have heretofore called *Zaphrentis spatiosa*. It is a short, rapidly expanding species. Length of the typical specimen 3 inches, width at the margin 2½ inches,

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* For the sake of brevity, I shall hereafter make use of the word columella.

where there are about 90 low rounded septa, somewhat unequal in size but in general 6 or 7 in the width of ½ an inch. As all the specimens seen, are partially filled with siliceous limestone, which cannot be removed by the application of acid, I have not, therefore, been able to ascertain the characters of the bottom of the calice. Corniferous.

11. H. EXCELLENS.—Corallum turbinate, moderately curved, expanding to a diameter of 2½ inches in a length of 6. Surface with numerous more or less angular folds of growth. Depth of calice 21 lines. Septa about 100 at the margin, rounded, slightly elevated, becoming sharp-edged and serrated as they descend. Bottom of the calice, striated by the edges of the large septa, a few of which reach the centre and ascend the columella. The latter 2 or 3 lines in height. A large and deep septal fossette. Corniferous.

12. H. COMPTA.—Corallum turbinate, curved, expanding to a diameter of 18 lines, in a length of 4 inches. Surface with rounded or sub-angular folds of growth. Calice 12 lines in depth. No columella. A moderate sized, septal fossette. There are about 100 septa at the margin of the cup. Corniferous.

13. H. PROLIFICA.—This species was published in Canadian Journal, March, 1859, and was made to include a number of closely allied forms, which could not be then separated for want of sufficient material. I now propose to confine it, to the group typified by the specimen figured with the original description, and in the Geology of Canada, page 365. It may be thus described—Corallum simple, turbinate, curved, expanding to a width of from 18 to 24 lines in a length of from 2 to 4 inches. Surface with a few undulations of growth. Septal striæ 8 to 10 near the base and 6 to 8 in the upper part in a width of 3 lines. Septa from about 100 to 120 at the margin (where they are all rounded), most common number from 100 to 110. In general they alternate in size at the margin; the small ones becoming obsolete on approaching the bottom of the calice; the large ones more elevated and sharp edged. The septal fossette is large and deep, of a pyriform shape, gradually enlarging, from the outer wall inwards for one-third, or a little more, of the diameter of the coral, at the bottom of the calice. Its inner extremity is usually broadly rounded or, sometimes, straitish, in the middle. It cuts off the inner edges of from 8 to 12 of the principal septa

which may be seen descending into it to various depths. The surface layer of the bottom of the cup, extends the whole width, bending downwards a little near the margin, as in *Zaphrentis*, and uniting with the inner wall of the cup all around. It thus seems to represent one of the tabulæ of a *Zaphrentis*. The following are the principal variations observed in this part of the fossil.

1. Specimens with a perfectly smooth space in the bottom of the cup; no columella.
2. A smooth space with a small conical tubercle near the centre.
3. Smooth with a small ridge, two lines in length and half a line in heighth and width.
4. Smooth with a compressed columella 3 lines in length, 2 lines in height, most elevated next to the fossette, gradually declining in height towards the opposite side.
5. Smooth spaces very small, columella, a low elongated ridge, with a few tubercles on its crest.
6. Columella well developed, but with tubercles on it and around it.
7. Septa reaching the columella and more or less corrugated and either with or without a columella.

In all cases where the columella is elongated, its length extends in a direction from the fossette to the opposite side. In those which have the septa extending to the centre the columella is often represented by a low rounded elevation.

It is difficult, perhaps impossible, to decide whether or not this group of forms, is specifically distinct fram *H. excellens*. The greatest difference is seen in the surface characters. In *H. excellens* the folds of growth are in general numerous and angular, although some are rounded. In *H. prolifica* they are in general few and nearly always rounded. In *H. excellens* I have only been able to make out the septal striæ distinctly in one specimen. At 1 inch from the base there are 5 and at 2½ inches 4 in the width of 3 lines. In *H. prolifica* there are 8 to 10 at 1 inch, and 6 to 8 at 2½ inches.

To this may be added that *H. excellens* is extremely rare, while *H. prolifica* is very abundant.

H. prolifica is abundant in the Corniferous. I have seen only one specimen from the Hamilton group.

Genus GYROCERAS.

14. G. NUMA.—The only specimen of this species in the collection is a cast of the interior, which is sufficiently perfect to give us the number of the whorls and their form, but does not show the distance of the septa from each other, nor the position of the siphuncle. Shell large, consisting of about three whorls, all in contact, except a small portion of the last one at the aperture, which is disengaged. The dorso-ventral diameter of the whole coil is about 10 inches; of the two first whorls about 3½ inches. The transverse diameter of the third whorl at its smaller extremity is 30 lines; dorso-ventral diameter of the same about 21 lines. The dorso-ventral diameter of the last whorl at about the point where it becomes separated is 4 inches, but as only a part of the transverse section of this whorl is seen, and the shell appears to have been compressed laterally, this dimension may be too great. On the ventral side of the last whorl there is a wide, slightly depressed furrow along the median line. This also may be the result of pressure. On a part of the second whorl, six or seven shallow rounded annulations are indicated, each of them two or three lines wide, and separated by grooves of the same width. A fracture in one place shows that the septa are deeply concave. As the aperture is broken away, it cannot be determined how much of the last whorl is free in the perfect fossil, but judging from appearances I should say not much more than two inches. Corniferous.

Genus ORTHOCERAS.

15. O. ANAX.—Shell about 2 feet long and from 3 to 3½ inches in diameter at the aperture. Septa from 6 to 8 in a length of 2 inches, where the diameter is 18 lines. Siphuncle nearly central, cylindrical or nearly so, 2 lines in thickness where the diameter of the shell is 16 lines.

The best specimens in the collection, (those from 1½ to 2 feet in length) show none of the septa except in the 5 or 6 inches of the smaller extremity. One only, shows a single septum which is 5½ lines deep where the diameter is 2¼ inches. In the same locality, and in the same state of preservation, were found a number of fragments in which there are 8 or 9 septa in a length of 4 inches, where the diameter is between 2 and 3 inches. I think these all belong to the same species.

Genus LICHAS.

16. L. SUPERBUS.—The frontal lobe of the glabella of this extraordinary trilobite has almost exactly the form of an egg, covered with tubercles, and placed on the anterior half of the head; its greater length corresponding, in direction, with the length of the body. Behind this there are two much smaller, sub-conical elevations, separated from each other by a depressed space or channel, the bottom of which is either flat or slightly convex. Close behind these the occipital furrow crosses the head; and next in order, the occipital ring or neck segment. The channel between the cones, proceeding in a direction forwards, divides into two branches, which diverging right and left, separate the anterior sides of the cones from the posterior part of the large frontal lobe. The base of the frontal lobe has a concave constriction all around, so that on a side view, the lobe seems to stand upon a low pedicel, nearly as broad as itself.

Judging from the fragments I have examined, if a perfect specimen were placed flat on the ventral side, then the depressed space or channel between the two posterior nodes of the head, would be horizontal, while the longer axis of the ovate frontal lobe would slope forwards and downwards, at an angle of between 60 and 80 degrees. In this position the length of the head of one of our specimens is about 3 inches, divided as follows: width of the neck segment 4 lines; from the neck segment to the posterior part of the median lobe 12 lines; thence to the most projecting point of the frontal lobe, forwards, 17 lines, in all 33 lines.

Placing the base of the frontal lobe in a horizontal position, the dimensions are as follows: greater length of the lobe (along the median line) 21 lines; greatest width about the mid-length 17 lines; greatest height above the constriction that surrounds the base 10 lines.

The frontal lobe, although 21 lines in length, owing to its sloping condition, only contributes about 17 lines to the length of the head.

The width of the space, between the bases of the two cones is six lines; height of the cones 5 lines. These cones perhaps represent the anterior pair of the glabellar lobes of an ordinary Lichas.

We have one specimen in which the length of the frontal lobe is 3 inches and its width about 2 inches.

The surface is covered with tubercles of various sizes up to 2 lines in width in the largest specimens. The space between the 2 cones is nearly smooth.

There are about a dozen specimens of the frontal lobe in the collection, and they vary from a length of 9 lines up to 3 inches.

Occurs in the Corniferous.

CHANGES OF NOMENCLATURE.

In 1860–1861, I described, in the Canadian Journal, a number of species of Devonian fossils, which appeared to be new. During the thirteen years that have elapsed, many changes have taken place in palæontological nomenclature, and several of the names then adopted must be changed.

1.—*Athyris Clara*, also described by Prof. Hall under the name of *Meristella elissa*. I am informed that this species has been long understood to be *Atrypa nasuta*, Conrad, although it was not recognized as such by Prof. Hall in 1860. If it is truly Conrad's species it should be called *Athyris nasuta*.

2.—*Rhynchonella ? Laura*, published May, 1860, is the same as Prof. Hall's *Leiorhynchus multicosta* of a later date. See Am. Jour. Sci. 2d Ser. vol. 31, p. 293. Our species may be called *Leiorhynchus Laura*.

3.—*Stricklandinia elongata*, may be changed to *Amphigenia elongata*.

4.—*Strophomena inæquistriata* is *S. inequiradiata*, according to Prof. Hall.

4.—*Favosites basaltica*. When Goldfuss published this species he figured three specimens:

4*a*—From Lake Erie. 4*b*—from Gothland. 4*c & d*—from Eifel.

These represent, either two, or three species. The specific name can only be retained for one of these species. The question to be decided is "which of them"?

Lonsdale and McCoy, have expressed the opinion, that the specimen (*c*, *d*), from the Eifel, is *F. Gothlandica*. Prof. H. A. Nicholson, says in reference to this opinion, that "it is probable."—(Canadian Journal, 1873 ?)

Supposing these three authors, to be correct in this view—then (*c*, *d*) must be referred to *F. Gothlandica*, and the name, *F. basaltica*, retained for either one or both of the others.

The specimen figured by me as *F. basaltica*, is of the same species as 4*a*.

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THE LIGNITE FORMATIONS OF THE WEST.

By George M. Dawson,

Assoc. R. S. M., Geologist B. N. A. Boundary Commission.

The true Carboniferous formation and that with which the greater part of the valuable coals of the world are associated, and which is so largely developed in the eastern half of the American continent, from Nova Scotia southward, does not appear in the western prairie region. Its north-western border lies in the eastern part of the Territory of Nebraska and in Iowa, where the thickly wooded country of the east has already passed into the prairie land of the west. Here, however, this formation, depended on for fuel in so many parts of the world, to a great extent loses its coal-bearing character. In Nebraska it has now been pretty thoroughly explored, both by surface examination and by boring, and yet has only yielded coal in very sparing quantities. Coal seams of 18 inches and 2 feet are described, and one which has been pretty extensively worked in the vicinity of Nebraska city, is not more than 8 inches in thickness. Such coal beds as these would not be workable in England or on the continent of Europe, with all the cheap and skilled labour there at command, and in a new country like Nebraska are only rendered so by the extreme scarcity of wood for fuel, the coal, such as it is, being sold at prices ranging from about 40c. to 80c. per bushel.

Hayden and other United States geologists, who have examined this region, consider it to be upon the western lip or margin of the true coal formation. Even in the State of Iowa the coal beds are of comparatively small importance. The formation is thin and irregular, and the coals themselves contain an excess of moisture and much ash and sulphur. In this western country the sandstones and mud rocks, usually associated with coal, are gradually replaced by limestones, indicating deeper water and conditions unfavourable to the formation of coal beds, as pointed out by Professor Hall.

Poor as these western coal-bearing rocks are, they labour under the additional disadvantage of being in great part covered by a newer formation, the Cretaceous; and where the Carboniferous formation again comes to the surface along the Rocky Mountain region of uplift, to the west of the great plains, it has not been found to contain so much as a single seam of coal, but is represented by massive limestones, shewing deposit in deep ocean water, and so far removed from land that it is rare to find in them even a fragment of any of the plants which were growing so luxuriantly in the swamps and deltas of the eastern half of the continent at the same time. Just where the coal of the recognized formation fails, the luxuriant growth of timber of the east also comes to an end, and the country assumes that prairie character which persists with scarcely a break to the foot of the Rocky Mountains. The bare rolling grassy hills and plains, though in many places eminently suited for agriculture, seldom yield wood for fuel or construction. Trees as a rule are only found fringing the deep river valleys, and in steep-edged gullies, where they are protected from the sweep of the prairie fires, and find a permanent supply of moisture.

In the western portion of the Dominion, in Manitoba and the Red River country, the Carboniferous formation is not found at all, but the Cretaceous rocks already alluded to, overlap the limestones of the older Silurian period. The true coal formation can only be supposed to exist there below a great thickness of Cretaceous rocks, and even if accessible the probability of coal of any value being found in it is, from analogy with the regions already mentioned, exceedingly small.

Neither do the Cretaceous rocks of the eastern portion of the plains yield, so far as known, any fuel of economic value in their great stretch from the borders of Mexico to the northern part of the British North-West. They consist almost entirely of clay rocks and sandstones, with one interesting zone of limestone and marl, which forms part of Hayden's group 3, or *Niobrara Division*, and which appears to be recognizable in Manitoba at Pembina mountain.

The lower part of this formation, however, in Nebraska, and on the Missouri river, seems to show an attempt at the production of beds of fuel. Beds of "impure lignite" of small thickness and of "carbonaceous clays" are met with there, especially in Hayden's lowest, or *Dakota Group*. Fossil leaves and stems are also found associated with these beds. and one lignite occurring in beds believed to be transitional between the *Dakota Group* and the *Fort Benton Group*, next above it, is even stated to have been worked to a small extent, and to have been "used by blacksmiths with some success."

There is therefore a possibility that the eastern edge of the Cretaceous in some regions may yet give a supply of fuel; and in Manitoba, the lower beds, and those in which the deposits above mentioned occur further south, probably lie east of the escarpment of Pembina mountain, and further east than the Cretaceous formation is made to extend in Hind's Geological Map, which has hitherto been the authority for the region. These lower beds, if they still exist beneath the alluvium of the Red River valley, are nowhere exposed, and cannot be explored except by boring operations. The possibility of the existence of fuel in the representative of the *Dakota Group* in Manitoba is much increased if the coal beds of the Upper Saskatchewan, examined last summer by Mr. Selwyn, are, as he supposes, of Lower Cretaceous age also, for in this case there would appear to be a tendency in the Lower Cretaceous formation east of the Rocky Mountains to become coal-bearing northwards.

Dr. Hector, many years ago, referred lignite beds observed by him in this region, to the same period. In view of these facts the position and character of the Cretaceous rocks occurring in Manitoba and the neighbouring country, becomes an interesting and important subject of inquiry.

Fortunately, however, the advance of settlement and civilization on the Western plains need not wait for the development of these possibilities, or for the tedious process of the planting and growth of trees suitable for fuel. A great deposit of fossil fuel, of still later age than the Cretaceous, has of late years been prominently brought to notice in the Western States, and the northern extension of this lignite formation of Tertiary age is largely developed in the Canadian Northwest. The existence of these fuels on the eastern side of the Rocky Mountains has long been known in a general way. Sir Alexander Mackenzie, the explorer of the river of the same name, in his account of his voyages of discovery prosecuted during the years 1789 to 1793, says that along the eastern side of the mountains there exists "a narrow strip of very marshy, boggy, and uneven ground, the outer edge of which produces coal and bitumen; these I saw on the banks of the Mackenzie River, as far north as Lat. 66°. I also discovered them in my second journey at the commencement of the Rocky Mountains, in 56° N. Lat.; 120 W. Long.; and the same was observed by Mr. Fiddler, one of the servants of the H. B. Company, at the source of the South branch of the Saskatchewan, in about Lat. 52; Long. 112° 30'." He also describes near the Peace River, "several chasms in the earth which emitted heat and smoke which diffused a strong sulphurous stench,"—probably a case of the spontaneous combustion of a lignite bed comparable with those observed in other localities. Sir John Franklin in his second journey to the Polar Sea, noticed what he calls beds of lignite or tertiary pitch-coal at Garry's Island, off the mouth of the Mackenzie River, and also an extensive deposit near the Babbage River, on the coast of the Arctic Sea, opposite the termination of the Richardson chain of the Rocky Mountains. Sir J. Richardson, who accompanied Franklin in the expedition just referred to, was one of those engaged in the search for him in subsequent years, and mentions in his account of a boat voyage on the Mackenzie and in the vicinity of Great Bear River, a species of coal which when recently extracted is massive but shows woody structure, the beds appearing to be made up of pretty large trunks, the fibre of which is contorted. He says that when this coal is exposed a short time to air it splits into rhomboidal fragments, which again separate into thin layers, and much of it eventually falls into a coarse powder. When exposed to moist air, it takes fire and burns with a fetid smell, but with little smoke or flame. Some varieties resemble charcoal, and others are conchoidal like cannel coal. Amber is also noticed to occur, and the beds of coal are often destroyed as exposed by their spontaneous inflammability. This description and the account given of the associated clays and shales might almost as well apply to some localities in the southern part of British America or to the lignite tertiary formation of the Missouri River.

In the United States the first observers of this formation appear to have been Lewis and Clarke, who, in the narrative of their expedition on the Missouri in 1804, mention somewhat fully the occurrence and distribution of the rocks of this formation. Many other explorers have since that time noticed the occurrence of this lignite formation even as far south as the Arkansas River, but till the inception of the trans-continental railway, it was thought of as lying too far west to be useful. The explorations connected with the railway and its construction, and the simultaneous growth of an important gold and silver mining region in Nevada and other western territories, with the explorations of Hayden and other geologists, have brought the great Lignite Tertiary Basin of these regions to notice in a manner commensurate with its importance. The lignite coals of this formation are now very extensively worked in several places near the line of the Union Pacific, and are found to subserve all the ordinary purposes of the more perfect coals of the true Carboniferous formation. They are used on the railways, and also for the metallurgical treatment of ores.

The region examined by me during the latter part of last summer, lies for the most part immediately north of the International Boundary, which crosses the continent from the Lake of the Woods to the Pacific Ocean, on the 49th parallel of latitude. Of the country through which the line passes, about 300 miles from East to West, have remained unknown even geographically until explored by the Boundary Survey during last summer, and the Lignite Tertiary formation described in this paper lies almost entirely in this hitherto unvisited region.

In proceeding westward from Red River, the Cretaceous beds already mentioned are met with in the region of the escarpment called Pembina Mountain, and in the streams which flow down over it, and occasional exposures of these rocks are found for a distance of about 45 miles. Beyond this, for about 150 miles, no rock exposures whatever are to be seen in the vicinity of the Line, the whole surface of the plains being composed of drift materials and marly sands and gravels. The river valleys are deep and broad, but the banks are grassed from top to bottom, and though very generally strewn with boulders belonging to the drift formation, do not show any sections of the underlying rocks.

At about 240 miles west of Red River, the boundary line strikes the Lignite Tertiary formation; the prairie level rises at the same place by a gentle step, which may be considered as the first elevation towards the Coteau de Missouri, or region of high and broken ground which separates the waters draining by the Souris and Saskatchewan Rivers to Hudson's Bay, from those forming the northern tributaries of the Missouri River, and falling at last into the Gulf of Mexico. Here also the river valley of the Souris, which is the largest stream in proximity to the line, undergoes a remarkable change, its banks become scarped and bare, and are seen to be composed of stratified sands, clays and sandstones belonging to the Lignite formation. The beds here represented are probably among the lowest of the Lignite group, and near their base is a remarkable nodularly hardened sandstone, which has been formed by the action of the weather where it outcrops in the valley into a group of extremely picturesque and castellated rocks, known collectively by the half-breeds as the *Roche Percée.* The lower part of this sandstone is grey, and so soft that it may be cut and scraped away with a knife. The upper part is divided into thinner beds and is hardened by calcareous cement. Both layers show false bedded structure in great perfection, and the lower has been pierced by window-like openings, due to weathering along lines of jointage.

These rocks have been probably from time immemorial objects of superstition to the Indians inhabiting this region of the plains, and chiefly belonging to the Cree and Assineboin tribes. They have covered the lower soft part of the sandstone with rude carvings, some representing human figures on foot or on horseback, others various animals of the chase, and many merely resembling strings and necklaces of beads. These sandstones closely resemble those described in Wyoming and elsewhere to the south at the base of the Lignite tertiary, and which there weather into similar fantastic forms, to which names such as "Fairy's Caves," "Hermit's Caves," &c., have been applied.

For about 15 miles westward along the Souris Valley, many banks showing good exposures of the Lignite Tertiary rocks occur. The strata there represented probably overlie those of the Roche Percée, and contain many beds of lignite, which those seen immediately underlying the sandstone do not.

The beds in association with which the lignites occur are mostly arenaceous clays, sometimes changing into moderately coarse sands or soft sandstones, but generally more resembling a true clay of a hard character, and frequently passing into a species of clay-shale. The colours of the beds are very varied, much more so than their texture, and a bank which from a distance frequently shows a perfectly banded appearance from top to bottom in shades of drab, yellowish, light brown and purple-grey, when approached more closely, loses all distinctness, and it is almost impossible to draw well defined lines between the layers in a measured section. The formation, though showing some slight undulations on a small scale, does not appear to have any definite direction of dip, and it is therefore difficult to correlate the beds seen in different places.

Many seams of lignite coal crop out in this part of the Souris Valley, the thickest observed was 7 feet 3 inches, and from this they show all intermediate degrees of thickness down to layers of a few inches only.

The following is one of many sections seen in this locality, and may be taken as an illustration of the manner of alternation of the deposits. The beds are arranged in descending order:

	Prairie Sod	–	–
1.	Mixed Shale and Drift	7 to 8 feet.	
2	Lignite	6 feet	6 in.
3.	Greyish Sandy Shale	4 “	0
4.	Lignite	1 “	6
5.	Fine sand and shaly clays, greyish and yellowish, well stratified	14 “	0
6.	Ironstone (nodular)	2 to 4 in.	
7.	Greyish and whitish clay	2 feet	0 in.
8.	Carbonaceous shale	1 “	0
9.	Grey soft sandstone	1 “	8
10.	Lignite	1 “	0
11.	Laminated sandy clay, grey and yellowish	5 “	0
12.	Ironstone (nodular)	0 “	3
13.	Lignite	1 “	7
14.	Carbonaceous shale	1 “	6
15.	Lignite	2 “	2
16.	Grey sandy clay	2 “	0
17.	Lignite	1 “	5
18.	Sandy under clay, with large and small roots, poorly preserved	1 “	6
19.	Lignite	3 “	2
20.	Greyish soft sandy clay	–	–
		About 58	0

The upper lignite lies so near the surface that it is penetrated by the roots of shrubs and small trees growing above, and where exposed is soft and rotten. The lower lignites though not of great thickness are excellent in quality. Bed No. 18 is one of the very few instances where a well characterized underclay was found to lie below a bed of lignite.

Few recognizable remains of plants are found in this part of the region in connection with the lignites. Some beds, however, and often those in close association with the lignites, yield molluscan remains, representing two species of *Paludina* or *Vivipara* at least two of *Melania*, one *Corbula* and several *Unio*-like bivalves. All these resemble those described by Meek and Hayden, from the Lignite Tertiary further South, and the *Corbula* is probably identical with their *C. mactriformis*, and indicates that brackish as well as fresh waters took part in the deposition of the lower beds of this formation.

Another peculiar feature in connection with the lignite deposits is their tendency to burn away *in situ*, and below the surface of the ground. The beds become ignited by some prairie fire, or the camp-fire of some Indian or trader, or it may be spontaneously (though this seems improbable, as iron pyrites, the general agent of spontaneous combustion in coals, is absent in these lignites); and smoulder away for years, producing breaks in the edges of the bank by the caving in of superior beds, and giving rise to a material which is plentiful in many places, and resembles a scoriaceous lava, but is really a species of clinker produced by the fusion of the ashes of the lignite.

In continuing westward, and after having crossed the region of drift hills already mentioned as the Coteau de Missouri, the Lignite formation is again represented in all the valleys and gullies of the streams which now run southward, and form the upper parts of the North Western tributaries of the Missouri. Specially good exhibitions of the rocks are to be seen in the first of these large valleys, at a distance of 345 miles west of Red River, and also in another a few miles further west, which has been called Pyramid Creek, from a remarkable pyramidal hill formed by the wearing away of the softer beds of the formation from below a layer of harder sandstone, a block of which has formed the capping of the hill. The beds are everywhere nearly horizontal, showing merely local dips, and it does not appear that a great thickness is represented by the whole of the sections examined. One locality is remarkable as showing the greatest development of the lignite beds, and also for the abundance of remains of plants in moderately good preservation. This is nearly 400 miles west of Red River, and the chief exposure is something less than a mile south of the line, and in the Territory of Montana. A seam of lignite coal no less than 18 feet thick there crops out. The section, including this lignite, is as follows, in descending order :

1.	Surface soil	1	foot	0 in.
2.	Drift (quartzite pebbles)	1	"	6
3.	Yellowish and grey stratified sandy clays	9	"	0
4.	Lignite	0	"	9
5.	Brown, banded clays, with plants and some crystalline gypsum	5	"	0
6.	Lignite (weathering soft)	10	"	0
7.	Lignite (hard and compact)	8	"	0
8.	Soft grey sandstone	5	"	0
		40		3

The laminated clays of bed 5 when first exposed show plant remains in great perfection ; even the delicate fronds of ferns, which are here unusually common, showing every detail of their form. On drying, however, the clay becomes cracked and fissured, and it is with difficulty that the impressions can be preserved. The association of selenite crystals, isolated or in groups, with the clays and arenaceous clays holding plant remains, is very constant.

The upper part of the lignite bed weathers soft and forms a steep slope. The lower part is hard, and being divided by vertical jointage planes, like many true coals, falls into the stream in great rectangular blocks, and presents a vertical face.

The plants associated with the lignite beds are very numerous in species, but have not yet been fully examined. Many *flag* and *sedge*-like leaves occur. At least two kinds of Ferns are represented—a *Sphenopteris* and an *Onoclea* apparently identical with *O. sensibilis*, a form still living. There are also twigs of several coniferous trees, including a cedar, *Thuja interrupta* of Newberry, and apparently species of *Sequoia* and *Taxus* ; and from the microscopic structure of the lignites it would appear that most of them are made up of woods of this kind. Leaves of a great many species of *deciduous* trees also occur, and are generally full grown, and appear to have fallen in the order of nature, and at the change of the season, and floated quietly out into the great lakes, in the fine silty deposits of which they have been preserved. *Populus*, *Salix*, *Ulmus*, *Platanus*, and probably *Rubus* and *Hedera* are among the genera represented; and it is not the least remarkable of the facts indicated by these deposits that they thus prove that in a comparatively modern period the region now so entirely destitute of trees was covered by a dense growth of forest.

Though it must not be supposed that the lignites of this region are comparable with true coal as fuel, they are still of considerable value, and will play a very important part in the settlement of a country so destitute of wood, not only as fuel for ordinary use, but in the manufacture of bricks for constructive purposes from the abundant clays. Most of the samples obtained were necessarily merely outcrop ones, and these fuels deteriorate rapidly under the action of the weather; still the average of fixed carbon in 13 samples from widely separated localities was over 40 per cent, and the ash in nearly every case very small in amount and light in colour, indicating the absence of iron pyrites.

As examples of the composition, two analyses of lignites from good compact seams, where the bank had recently fallen away and exposed a fresh surface, are here given. The first is from a bed 7 feet 3 inches thick on the Souris; the second from the lower part of the 18 foot bed included in the last section, and at a distance from the other of considerably over 100 miles.

Souris R. Valley, 7 *ft.* 3 *in. seam.*		*Porcupine Creek*, 18 *ft. seam.*	
Water	15.11	Water	12.05
Fixed Carbon	45.57	Carbon	46.18
Volatile matter	32 76	Volatile matter	35.12
Ash	4.56	Ash	6 65

These lignites, therefore, while superior to many which are used in other parts of the world, are somewhat inferior to the best class of lignite coals found on the line of the Union Pacific Railway, some of which contain from 45 to 53 per cent. of fixed carbon. These occur in detached basins of this formation, but probably in lower beds than those now described, and have also been improved by metamorphism connected with the elevation of the mountains with which they are in proximity, and with the contortion of the strata containing them, the lignites being in some cases actually on edge, and frequently inclined at high angles. Similar flexures will probably be found to affect the formation north of the 49th parallel, when traced towards the mountains, and the lignites may improve in quality in the same way. The deposits here described, however, gain much by their horizontal attitude and easy accessibility, and could probably be mined by a system similar to that known as *long wall*, at the expense of a comparatively small amount of mine timber, which in these woodless regions would be a great advantage. The iron-stones, though occurring frequently in proximity to the coals, have not yet been observed in workable quantity, but it is highly probable that further explorations may bring such localities to light. The ores are among the best of their kind, both as to percentage of iron and freedom from sulphur and phosphorus. None of the lignites yet discovered yield however a coherent coke suitable for the smelting of iron in the blast furnace.*

The conditions implied by the nature of these deposits are marshes, lakes and estuaries, on a grand scale, and from which the sea was for the greater part of the time excluded. The previous deposits of Cretaceous age show that at that time the whole western part of the continent was covered by a sea of some depth, in which during a long time before the advent of the lignite period, fine silty and muddy sediments were laid slowly down, and included the remains of *Cephalopoda* and *Lamellibranchiata* peculiar to that age. Then came on a period of emergence, coarser sediments were carried by the waters, and at last the sea was entirely shut off from the area in question and replaced by great lakes of fresh water, with wide swampy margins, where the lignites were slowly formed by the growth of trees and peaty moss.

Much question has lately arisen with regard to the true age of the representatives of these deposits in the Western States. The plants as compared with those of European formations, have a comparatively modern aspect, and were originally referred on good authority to the Miocene. The molluscous fossils occurring in marine beds connected with the base of the formation on its western margin, show Cretaceous affinities. Cope maintains that the Cretaceous age of the greater part, if not the whole of the formation, is proved by the existence in it of a few relics of Dinosaurian reptiles. It would seem indeed that in the regular passage of beds of well marked Cretaceous age upwards into the Lignite Tertiary formation, we have a case of the blending of two geological periods. but complicated by a simultaneous change over the area in question from marine to estuarine and freshwater conditions. It seems certain that the formation of lignites began in the Rocky Mountain region before the salt waters had entirely left the area, and consequently while forms generally known as Cretaceous were still living there. The evidence does not appear to show that the Cretaceous species were of themselves becoming rapidly extinct, but that over the Western region, now forming part of this continent, the physical conditions changing drove the Cretaceous marine animals to other regions, and it is impossible at present to tell how long they may have endured in oceanic areas in other parts of the world. This being so, and in view of the evidence of the preponderant animal and vegetable forms, it seems reasonable to take the well marked base of the Lignite series as that of the lowest Tertiary, at least at present. The formation described belongs to this lowest Tertiary, being in fact an extension of Hayden's *Fort Union group*, and from analogy may be called *Eocene*. Judging from Hayden's descriptions this Northern extension would appear to be richer in lignite beds than that portion represented on the Missouri River, and therefore to show a tendency in the lignites to increase in importance northwards as they do southwards of that region.

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* Mr. Miller, in some remarks made after the reading of this paper, mentioned the successful employment of charcoal made from similar lignites in Germany, in iron smelting.

NOTE ON THE OCCURRENCE OF FORAMINIFERA, COCCOLITHS, &c., IN THE CRETACEOUS ROCKS OF MANITOBA.

By G. M. Dawson, As. R. S. M., &c.

A great portion of the Cretaceous division in England and on the Continent of Europe, is composed of typical chalk, a substance which must have been formed in the tranquil depths of the ocean, far removed from land, as it contains but a very small proportion of any earthy impurity. It consists in great part of the calcareous shells of Foraminifera, and the still more minute calcareous bodies known as Coccoliths. The remains of the larger Molluscs and of Echinoderms occur but rarely. The American representative of this formation contains no beds of true chalk, but is made up for the most part of deposits of sand

and clay, indicating comparatively shallow-water conditions, and the proximity of land. The nearest approach to chalk is found in the interior continental basin, especially where the Cretaceous rocks are finely exposed along the Msssouri River, and where in Hayden's third group or Niobrara division a soft white shelly limestone occurs. It forms bold bluffs on some parts of the river, and the name "chalk" is popularly applied to it, and is justified by the fact that it contains large numbers of Foraminifera, some of which from the Cretaceous of the Missouri and Mississippi have been described by Ehrenberg.

In Manitoba, the rocks of the Cretaceous Series are much masked by drift material, and do not in any place I have seen yield fossils in any quantity Through the kindness of Mr. A. T. Russel, I have however received specimens from a locality about twenty miles north of the 49th parallel, on the escarpment called Pembina Mountain, which exactly resemble the so-called "chalk" of Nebraska, and contain interesting organic remains.

The greater part of this rock is composed of shells of Inocerami and oysters, the latter probably identical with *Ostrea congesta*, characteristic of the Niobrara division further south. These shells are imbedded in a soft whitish earthy matrix, which on microscopic examination proved to be rich in Foraminifera, Coccoliths, and allied organisms.

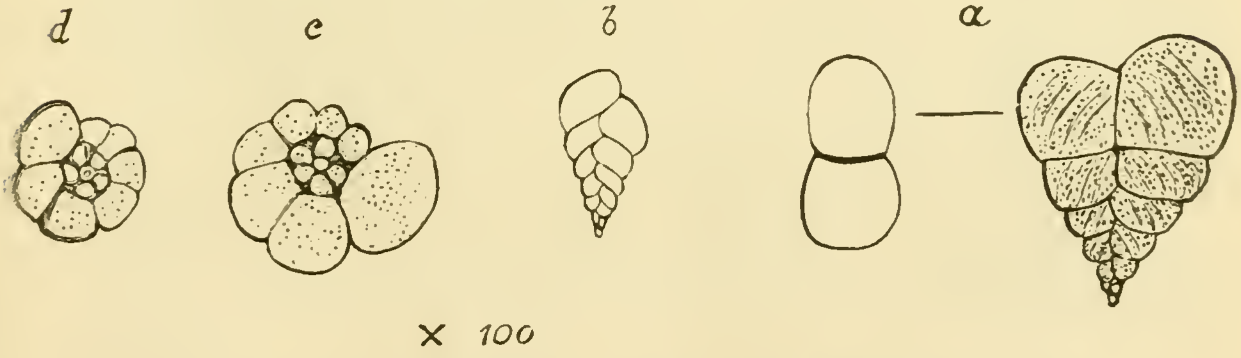

Fig. 1. Foraminifera from the Cretaceous of Manitoba.
(*a*) Textularia globulosa. (*b*) T. pygmæa. (*c*) Discorbina globularis. (*d*) Planorbulina Ariminensis.

The commonest foraminifers belong to the genus *Textularia*, and represent two of its varieties. Of these the predominant is a stout form with globose chambers rapidly increasing in size at each addition, and sometimes even as broad as long. The primordial chamber, and those next it, are often bent away several degrees from the axis of symmetry of the larger part of the shell. The surfaces of the chambers are marked with extremely minute diagonal interrupted ridges or wrinkles, which may also be seen in specimens from the English chalk. This form is doubtless identical with *T. globulosa*[*] of Ehrenberg, noted as being in cretaceous material from Dakota and Nebraska, and falls under D'Orbigny's species *T. gibbosa*.[†] *T. globulosa* was found by Ehrenberg in the Brighton and Gravesend chalk, and is one of the commonest forms in the latter. It also occurrs in the Meudon chalk of France, and is still living in the Mediterranean and elsewhere, in depths of from 50 to 100 fathoms.[‡]

The second Textularine form is usually smaller and more delicate than the last. It is longer in proportion, considerably flattened, and with more elongated chambers. It is comparatively rare. Not unfrequently the first two or three chambers are very small, and arranged almost in a linear series. This may be equivalent to *T. Missouriensis*, or one of the other forms recognized by Ehrenberg, but according to the revised nomenclature may be included under *T. agglutinans*, variety *pygmœa*, D'Orbigny. This form is closely allied to if not identical with one found in the English chalk, and is common at the present day in the North Atlantic and elsewhere, becoming, however, rare and small at great depths, and appears to be most at home in about 90 fathoms in the latitude of England.[§]

Both of these Textulariæ are small and frequently deformed, and there are forms more or less intermediate between the types here described. Both types appear prominently in the material I have studied from the Upper Missouri,[||] and Ehrenberg's additional varieties, if his specimens were such as I have seen, were probably based on transitional or more or less abundant forms which might be included with advantage under these types. Both forms have a weak and depauperated appearance.

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[*] Smithsonian check list of Cretaceous Fossils.

[†] See Parker and Jones, Geol. Mag. Vol. viii. No. 11.

[‡] The same species or a variety of it seems to be named *T. Americana* by Bailey, in Silliman's Juurnal, vol. 46. In any case, a comparison of specimens shows that the common species at Pembina Mountain is even varietally identical with one common in the English chalk.

[§] Parker and Jones on North Atlantic and Arctic Foraminifera.

[||] Specimens presented by the Smithsonian Institution to the Museum of McGill College, from "Eau qui Court," on the Niobrara River, about 500 miles South of Pembina Mountain, are very similar to those from the latter place, containing the same Foraminifera and abundant Coccoliths and Rhabdoliths, with *Ostrea congesta*.

The common spiral Foraminifer in the Pembina Mountain specimens, is *Discorbina* (*Rotalia*) *globularis*, D'Orb. sp., and is probably identical with *Rotalina* (*Rotalia*) *globularis*, characteristic of and very common in the upper and lower chalk of England. This form is also common in the specimens from Nebraska, and must be the same as *Planorbulina globulosa*, recognized by Parker and Jones from Ehrenberg's figures as occurring in the Mississippi Cretaceous.* These authors there remark that *Planorbulina globulosa*, Ehr. sp. "must not be regarded as worth much, being a very minute Rotaline, and such a form as several species might present in their earliest stage of growth." It forms, however, a well marked type in the Manitoba and Nebraska deposits, and as no larger examples occur, must be regarded as an adult though depauperated variety. It is common everywhere at the present day. In the North Atlantic it is best developed from the shore down to 50 or 70 fathoms. It becomes flatter at greater depths. The specimens from Manitoba are considerably flattened.

A second Rotaline, smaller and flatter than the rest, and with more delicate chambers and more in a whorl, is referable to *Planorbulina* (*Planulina*) *ariminensis*, D'Orb. sp., included under *P. farcta* by Messrs. Parker and Jones, and belongs to the series of small quasi Rotalian and Nautiloid forms, more or less symmetrical, which they state † to be very common in some secondary deposits, and abundant in the present seas at from 100 to 1000 fathoms. *P. ariminensis* is common in the English chalk, in that of Möen, Denmark, and doubtless elsewhere. It is also found in Tertiary and recent deposits. *Globigerinæ*—referable to *G. cretacea*, also occur, and an examination of a larger quantity of material than that now at my disposal would no doubt bring to light many additional forms.

The general facies of the foraminiferal fauna of these Cretaceous rocks of Manitoba and Nebraska singularly resembles that of the ordinary English chalk. Both abound in Textularine and Rotaline forms of similar types, the most abundant in both being the form with globose chambers, and each having its rarer analogue with chambers flattened and more delicate.

To the bodies now included under the general name *Coccoliths*, attention has only been prominently drawn of late years. Ehrenberg long ago recognized them as forming an important constituent of the English chalk, and supposing them to result from a rearrangement and partial crystallization of the particles of carbonate of lime, called them "morpholites." The name by which they are now known was applied to them by Prof. Huxley, who found them to be characteristic of many deep sea sediments, where they appear in conjunction with the Amœba-like *Bathybius*. It is still a question in dispute, whether they form an integral part of that organism. *Rhabdoliths* were discovered by Dr. O. Schmidt in 1872* in the Adriatic Sea, in association with Coccoliths, with which they appear to be closely allied in structure and mode of increase. I do not know that they have heretofore been found in the fossil state.

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* Quart. Jour. Geol. Soc. 1872.

† Memoir on Atlantic and Arctic Forams.

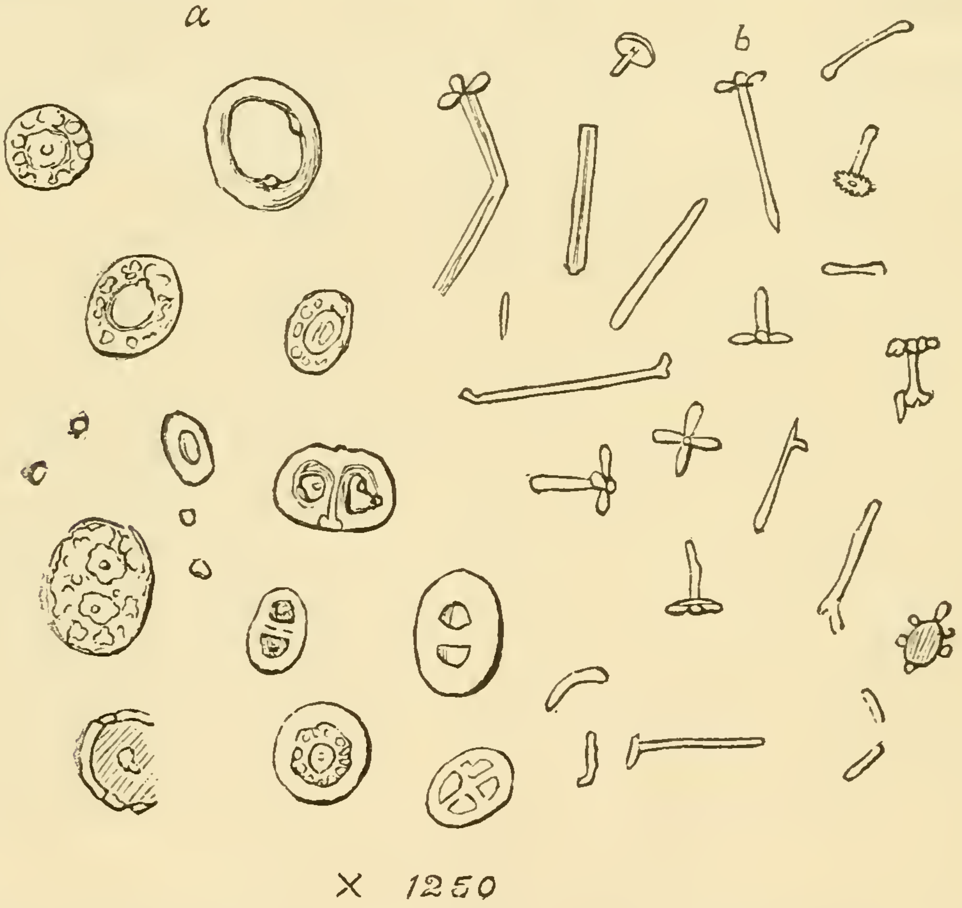

Fig 2. Various forms of Coccoliths (*a*) and Rhabdoliths (*b*) from the Cretaceous of Manitoba.

In the samples of Cretaceous limestone from Manitoba and Nebraska, both Coccoliths and Rhabdoliths are abundant, and constitute indeed a considerable proportion of the substance of the rock. The engraving represents a selection of the forms observed, magnified about 1250 diameters. The *Rhabdoliths* agree closely with those figured by Dr. Schmidt, † and pass through nearly the same set of forms as those there represented. The Coccoliths agree with those figured in the same place exactly, and also with those found in the English chalk and recent seas. They are in a remarkably good state of preservation. The average diameter of the larger among them is about ·003 millimetres, which agrees very nearly with that of those found in other places. Dr. Gumbel has discovered Coccoliths in limestones of many ages, and they appear, though so minute even in comparison with the Foraminifera, to have played no unimportant part in the fixation of calcareous matter, and the building up of the crust of the earth.

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* Ann. and Mag. N. H. 1872.

† Loc. Cit. Pl. xvii.

ON RECENT DEEP-SEA DREDGING OPERATIONS IN THE GULF OF ST. LAWRENCE.*

By J. F. Whiteaves.

During the summer of 1873, the Hon. the Minister of Marine and Fisheries of the Dominion of Canada very kindly placed one of the government schooners at my disposal, for dredging purposes. These investigations, which were undertaken on behalf of the Natural History Society of Montreal, had, as their primary object, an examination into the present condition of the Marine Fisheries of the Gulf, and were supplementary to similar explorations carried out by myself in the summers of 1871 and 1872. In the present paper, a short descriptive account will be attempted of some of the most interesting zoölogical specimens collected in 1873. Nearly nine weeks were spent at sea (from July 18th to September 8th); and during this time, although the weather was often unfavorable, we nevertheless got about seventy successful hauls of the dredge. The cruises were essentially four in number, but on the whole the first yielded the greatest number of novelties.

Cruise 1.—The first two weeks were devoted to an examination of the deep water in the centre of the mouth of the river, between Anticosti and the Gaspé Peninsula. The most interesting specimens were obtained in from 200 to 220 fathoms, mud; and among them are the following:

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* From the Am. Journal of Science and Arts for March, 1874.

FORAMINIFERA.—*Marginulina spinosa*, M. Sars; a large *Triloculina* allied to *T. tricarinata*, perhaps *T. cryptella* D'Orb.; curious arenaceous forms, new to me, some of which are simple and unbranched, others widely triradiate, while a third series is irregularly cruciform, and even five and six rayed. They are all, most likely, forms of one species; but whether they are the *Asterorhiza limicola* of Sandahl or not, I have at present no means of ascertaining.

SPONGES.—One specimen of *Trichostemma hemisphæricum* M. Sars; one of *Cladorhiza abyssicola* M. Sars; and about a dozen of the *Hyalonema longissimum*, of the same author, were taken in 220 fathoms. With these occurred another species, which is either a true *Tethea*, or belongs to a closely allied genus. In shape it is more or less pyriform, somewhat triangular in section, and with a flattened base. There are three orifices, corresponding to the three angles, of which two are basal. These are connected on two sides by a perforated canal or tube. The front basal orifice is partly closed by an outer fine open network and an inner and coarser one of siliceous spicules, the latter not very unlike those at the apex of *Euplectella*; and this opening seems to be the point of attachment to small stones, etc. The whole sponge is densely hispid with projecting spicules, which are sometimes of considerable length. These are mostly very attenuate; some of them are simple, and these are either straight or flexuous; others are simply ternate or biternate at one end; some again are anchorate at the extremity, with three or four slender flukes. In its canal connecting the three external and larger openings, and in its beautiful open network of spicules, it seems to differ generically from *Tethea*. In the shape of its spicules, but not in some other respects, it resembles the *Dorvillia agariciformis* of Mr. W. S. Kent, and the *Tethea muricata* of Bowerbank. As the Canadian sponge may possibly be the same as Dr. Bowerbank's imperfectly characterized species, I refrain for the present from giving it a name. It is only fair to add that before I had dredged this species in a living state, my friend Mr. G. T. Kennedy, M.A., had found specimens in the Post-Pliocene clays of Montreal, which are undoubtedly conspecific with it.

ACTINOZOA.—A few individuals of *Pennatula aculeata* Dan., var., and of *Virgularia Ljungmanii* Köll., were taken in the deep-sea mud, together with large tubes apparently belonging to *Cerianthus borealis* Verrill, though the animal of this latter species has not yet been taken in the Gulf. *Cornulariella modesta* Verrill, was collected (in 1871) at depths of 220 fathoms, between the east end of Anticosti and the Bird Rocks.

ECHINODERMATA.—*Schizaster fragilis* Dub. & Koren, and *Ctenodiscus crispatus*, are common in the deep-sea mud, as are also *Ophiacantha spinulosa* M. & T., and an *Amphiura* whose specific relations are still obscure. The Ophiuridæ collected during this cruise have yet to be studied. One living example of * *Ophioscolex glacialis* M. and T. was dredged in 210 fathoms, to the southwest by south of the Southwest Point of Anticosti.

POLYZOA.—A beautifully perfect specimen of *Flustra abyssicola* of G. O. Sars, showing the singular avicularia, so characteristic of the species, was dredged in the centre of the mouth of the river, at a depth of 220 fathoms. Two examples of *Hornera lichenoides* (Linn.) and one of a peculiar variety of *Bugula plumosa ?* were dredged in the same place. *Escharella palmata* (M. Sars) was also sparingly taken in deep water.

MOLLUSCA.—The most abundant species collected at greater depths than 150 fathoms are *Pecten Grœnlandicus* Ch., and *Arca pectunculoides;* but *Portlandia lucida*, *P. frigida*, *Philine quadrata*, *Cylichna umbilicata* Mont., *Dentalium attenuatum** *?* Say, and *Siphonodentalium vitreum* Sars, also occurred, though more sparingly. Two living speciment of *Cerithiopsis costulata* Möll. (the *Bittium arcticum* of Mörch) were dredged in the 220 fathom locality.

CRUSTACEA.—The deep-sea Crustacea are of unusual interest. Among them is a living specimen of *Calocaris MacAndreæ* Bell, the first, I believe, that has been observed on the American side of the Atlantic. In the same region, four specimens of a crustacean were collected, which belong, in my judgment, to a new

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NOTE—I am indebted to Prof. Verrill for the identification of several critical species, to whose names an asterisk (*) is prefixed; and the difficult Crustacea, whose appellations are preceded by a dagger (†), were kindly determined for me by Mr. S. I. Smith.

* If the shell described by the late Dr. Gould as *Dentalium dentale* be really the *Dentalium attenuatum* of Say, the latter name is much prior to Stimpson's *D. occidentale*. Having received a number of Norwegian specimens of *D. abyssorum* Sars, through the kindness of Mr. Jeffreys, and compared them with the St. Lawrence longitudinally ribbed species, I cannot see any differences which in my judgment are sufficient to separate them. At the same time, *Dentalium striolatum* St. seems to me a perfectly distinct and good species.

genus.* In its characters, this genus (for which I venture to propose the name *Munidopsis*) approaches nearer to *Munida* than to *Galathea*. On some future occasion I hope to be able to give a detailed description, with figures, of this form; for the present a short diagnosis only of some of its salient points will be attempted. Of the limited genus *Munida*, only two or three species are known at present. *Munida rugosa* (Fab.) is the same as *Munida Rondeletii* of Bell, and *Astacus Bamffius* of Pennant. The other species are *M. tenuimana* of G. O. Sars, and *M. Darwinii* of Bell.

The following additional species of Crustacea were collected from the deep-sea mud: † *Hippolyte Fabricii* Kroyer; † *Diastylis*, sp.; † *Pseudomma roseum* G. O. Sars; † *Thysanopoda neglecta?* Kroyer, and another large species; *Stegocephalus ampulla* Phipps; † *Harpina*, sp.; † *Epimeria cornigera* Fab.; † *Halirages fulvocinctus* Boeck; † *Melphidippa*, sp.; *Phoxus Kroyeri* St.; *Munnopsis typica* M. Sars; *Anthura brachiata* St.; and † *Nebalia bipes* O. Fab.

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* *Munidopsis curvirostra*, nov. gen. et sp. External antennæ about equal in length to the carapace and its rostrum; internal ones very short, not reaching farther than about one-fourth the length of the beak. Eyes *rudimentary*, longitudinally oval, light yellowish in color; *cornea devoid of facets*. Carapace squarish, but longer than broad, with an outwardly directed straight spine on each of the front angles. Upper surface of the carapace granulate, hispid, transversely irregularly plicate. In the centre there are two dorsal spines, placed one above the other, but at some distance apart. These, as are two similar spines on the tail segments, are all exactly in a line with the rostrum, and the whole four point forward. Rostrum *simple* (without the spine on each side of the base so characteristic of *Munida*), *conspicuously curved upward*, stout at the base and gradually tapering to a fine point. A single spine in the centre of the first and second tail segments, the rest devoid of any. Anterior pair of legs about as long as, but not longer than, from the apex of the rostrum to the end of the tail, extending a little beyond the tips of the outer antennæ. The following are the measurements of an average and apparently adult female: length, from apex of rostrum to tip of tail, 1·38 inch; of carapace, including the rostrum, ·69 inch; of exterior antennæ, ·75 inch; of anterior legs, ·94. Inhabits the centre of the mouth of the St. Lawrence River, between Anticosti and the south shore, in from 180 to 220 fathoms, and probably burrows in the deep-sea mud. From *Munida* it may at once be distinguished by its curved and simple rostrum. In the rudimentary character of its eyes it closely resembles *Calocaris*, but not in many other respects.

FISHES—A fine living example of *Macrurus rupestris* (Fab.), the *M. Fabricii* of Sundevall, was brought up by "tangles" from a depth of about 200 fathoms.

During this cruise we were driven into Gaspé Bay for shelter from a heavy gale blowing outside, and were detained there about four days. At the entrance of the bay, some dredging was done in depths of from 30 to 50 fathoms. The most interesting forms obtained here were *Myriotrochus Rinckii* Steenstr.; *Priapulus caudatus;* both species of *Hyas;* an undetermined † *Eudorella;* *Acanthozone*, nov. sp., fide S. I. Smith; † *Syrrhoë crenulatus* Goes (several); † *Vertumnus serratus* Goes; † *Pontoporeia femorata* Kroyer; † *Haploops*, sp.; † *Melita dentata* Kroyer, and an allied species; as well as some interesting sponges. † *Gammarus ornatus* Edwards, was abundant at low-water in St. George's Cove; it appears to be a common littoral form throughout the Gulf.

Cruise 2.—We left Gaspé Basin on August 2d, intending first to examine the two largest of the inshore banks, the Orphan and the Bradelle. At the outset the weather was very stormy, so we got under the lee of Bonaventure Island, and dredged outside the northern entrance to the Bay des Chaleurs, from Cape Despair to a little below Grand Pabou. *Ophioglypha Sarsii*, of large size, was abundant here, and two specimens of *Myriotrochus Rinckii* were taken in the same place. The crustaceans from this region are unusually interesting: among them are † *Hippolyte macilenta* Kr.; *Thysanopoda neglecta?* Kr.; *Pseudomma* (nov. sp.); species of † *Mysidæ* "near to *Erythrops* and *Parerythrops* of G. O. Sars"; † *Eudorella*, sp.; † *Leucon nasicus* Kroyer; † *Acanthostephia Malmgreni* Boeck; *Œdiceros lynceus* M. Sars; † *Aceros phyllonyx* Boeck; † *Byblis Gaimardii* Kroyer; † *Pontoporeia femorata* Kroyer; a species of † *Melita*. Also a curious fish, at present undetermined.

The breeze moderating, we at once made for the Orphan Bank. and devoted three days to dredging on it, remaining on the ground during the night so as to lose no time. The Orphan Bank, which is situated nearly opposite the entrance to the Bay des Chaleurs, is a stony patch, as are most of the fishing banks, many of which are not mapped out in the charts.

The masses of rock are often of large size, and consist chiefly of a reddish sandstone (perforated by *Saxicava* and *Zirphæa crispata*) associated with a few scattered pieces of Laurentian gneiss, &c. Soft-bodied organisms are peculiarly plentiful on this bank. The most characteristic of these are *Alcyonium rubiforme* Ehr., small varieties of *Urticina crassicornis; Ascidiopsis complanatus*, of unusual size and abundance; various other Tunicates; and quantities of common Ophiurids and Asterids. † *Metopa glacialis* Bœck, was occasionally met with between the inner and outer tunic of *Ascidiopsis*. The stones are often covered with encrusting sponges, of two or three species: *Grantia ciliata* was frequent, and with it there occurred another calcareous sponge which Prof. Verrill has identified as the *Ascortis fragilis* of Hæckel. Hydrozoa and Polyzoa are exceedingly abundant on this bank; the former seem to be mostly common northern forms. Among the latter, *Myriozoum subgracile* D'Orb.; *Cellepora scabra* Fab.; *Eschara cervicornis?* Pallas; *Caberea Ellisii;* and other species, were fine and frequent. Two fine specimens of *Porella lævis* (Fleming) were dredged at this locality. * *Boltenia ciliata* Möller; * *Molgula pannosa* V.; *Cynthia pyriformis* (Rathke); and *C. monoceros* Möll., occurred sparingly among the other Tunicates.

Among the Echinoderms are *Pteraster militaris*, *Asterias Grœnlandicus*, and *Psolus phantapus*. The rarest of the Orphan Bank Mollusca are *Amicula Emersonii* (Couth.), fine and frequent; *Mamma immaculata* (Totten); *Trophon craticulatus* (O. Fab.); *Buccinum tenue* Gray; *Neptunea Spitzbergensis* (Reeve); *Tritonofusus Kroyeri* Möll.; *Astyris Holbollii* Beck; and a few *Astarte lactea* of Brod., and Sowerby. Crustacea are peculiarly plentiful on this bank, particularly the two species of *Hyas; Eupagurus; Pandalus annulicornis; Crangon boreas*; *Nectocrangon lar* (fine); *Hippolyte spina;* † *H. Phippsii;* and † *H. pusiola.*

The Amphipods are represented by *Acanthozone cuspidata* (Lep.); *Tritropis aculeatus* (Lep.); and *Eusirus cuspidatus*. The Isopods by *Idotea marmorata* Packard, and by a *Bopyrus* which was found burrowing under the carapace of the common *Pandalus*. A small species of *Nymphon* was also dredged here.

At the end of the third day a stiff breeze from the southwest sprung up, accompanied with rain, and in consequence of this we made for Miscou Island for shelter. As soon as the gale moderated we proceeded to the Bradelle Bank, and on our way made one cast of the dredge between it and Miscou. In this haul, specimens of † *Hippolyte macilenta;* † *Pseudomma*, nov.

sp.; † *Byblis Gaimardii*; † *Ampelisca*, sp.; † *Ptilocheirus pinguis* St.; † *Melita dentata*; and † *Pontoporeia femorata*, as well as many Annelids, were collected.

The Bradelle Bank, which is situated almost due south of the one previously described, is also a stony patch, but the pieces of rock are usually small, and there is an admixture of gravel, coarse sand and mud. Its fauna is characterized by the abundance of its Mollusca, and by the apparent absence on it of many of the softer organisms so abundant on the Orphan Bank. The Hydrozoa and Polyzoa of the two banks are very similar, but on the Bradelle fine specimens of *Tubulipora lobulata*? Hassall, were collected. The most abundant shells on the Bradelle are *Astarte lactea* Brod. and Sow., *A. elliptica*, and *A. Banksii*; *Venus fluctuosa* Gould; *Cardium Grœnlandicum*; *Crenella nigra*; *C. lævigata*; *C. glandula*; *Macoma calcarea*; *Panopæa Norvegica*; and *Cyrtodaria siliqua*. Its greatest rarities are a single living example each of *Tritonofusus latericeus* Möller, and *Volutopsis Norvegicus* Chemn. *Rhynchonella psittacea*, of large size, is common on both banks. *Astrophyton Agassizii*; *Ophioglypha Sarsii*, large; *O. nodosa*; and *Psolus phantapus* are frequent on the Bradelle, where also a fine living specimen of *Ophiocoma nigra* Müller, was obtained. The Crustacea of both banks are for the most part similar, but on the Bradelle a few additional species occurred. These are *Crangon vulgaris*; †*Diastylis*, sp.; †*Ampelisca*, two species; †*Haploops*, sp.; †*Byblis Gaimardii*; †*Ptilocheirus pinguis*; †*Harpina*, sp.; †*Paramphithoë pulchella* Bruz.; †*Œdiceros lynceus*; †*Vertumnus serratus*; and †*Nebalia bipes*.

These two banks seem to be outliers, so to speak, inhabited by a purely arctic fauna, and surrounded almost entirely by a more southern assemblage. The shores of the Magdalen Group, of Prince Edward and Cape Breton Islands, as well as the whole of Northumberland Straits as far north as the southern entrance to the Bay des Chaleurs, are tenanted by a somewhat meagre Acadian fauna. Owing to the shallowness of the water on these two banks, the temperature is probably higher by some four or five degrees than the average of that in the northern part of the gulf. In sailing from Point Miscou to the Bradelle Bank we found the temperature of the bottom (Miscou Point, bearing northwest half north, 22 miles distant) was 42° Fahr. After examining the Bradelle Banks, we made for Pictou, Nova Scotia, and arrived there on the afternoon of August 11th.

Cruise 3.—Leaving Pictou on the 13th of August, we dredged to the S.W. and S.S.W. of Pictou Island, then to the N.E. and N.N.E. of Cape George (N. S.), and from there to a little distance off Port Hood, C. B. We next stood over to the east point of Prince Edward Island, dredging at intervals on the way. After this we examined the Milne Bank, also various parts of the bottom from there to Cape Bear (Prince Edward I.), and to the north of Pictou Island, and got back to Pictou on the 16th of August.

From Pictou to Port Hood and along the west side of Cape Breton, the sea bottom consists of red clayey mud, in which annelids are remarkably numerous and often of large size. At almost every cast of the dredge, tangled masses of tubicolous annelids (inhabiting tubes of from the $\frac{1}{16}$th to a quarter of an inch or more in diameter, and from one or one and a half inches to nearly eight inches in length) came up in handfulls. These, together with large naked species, are so abundant as to form more than two-thirds of the whole number of specimens taken. One specimen of †*Diastylis quadrispinosus* G. O. Sars, was dredged off Pictou Island. Hydrozoa and Polyzoa are tolerably abundant, and sometimes very fine, in the red mud; these have not yet been examined, but among them are *Sertularia argentea* of unusually large size, and a bushy species of *Gemellaria*. *Alcyonium carneum* Ag., is one of the characteristic species of the eastern part of this area, as is also an apparently undescribed species of *Priapulus*, very distinct from *P. caudatus*. Tunicates are not unfrequent in the red mud; the commonest of which are *Pelonaia arenifera* and *Eugyra pilularis*, while **Glandula fibrosa* St., occurred more rarely. With these, about sixteen species of shells were collected; they are all characteristic Acadian species. The temperature of the mud seems to range from 40° to 42° Fahr. Off Port Hood, two large specimens of a Holothurian were taken, which exactly agree with the drawing and description of the *Cucumaria pentactes* of O. F. Müller, as given by E. Forbes in his British Starfishes.

Off the east point of Prince Edward Island the bottom is sandy, and as the depth where we dredged does not exceed fifteen or twenty fathoms, the summer temperature is high, being affected by surface conditions. Two small specimens of *Eupyrgus scaber* Lutken, and one of *Molpadia volitica* Pourtales, were collected here, as well as examples of **Molgula papillosa* V. and

**M. producta* St. On the Milne Bank we dredged quantities of the common *Echinarachnius;* an abundance of fine Hydroids and Polyzoa; a few shells; and some small algæ.

Between Cape Bear and Pictou Island the bottom is sandy, with shells and a few small stones. Three kinds of sponges were collected here, many hydroids, echinoderms (all common forms), annelids, crustacea, and tunicates. Among the latter are specimens of **Molgula littoralis* V. Shells were particularly abundant, among them are *Pecten tenuicostatus*, *Modiola modiolus*, *Crenella nigra*, *Astarte undata* Gould, *Cyprina Islandica*, *Callista convexa*, *Pandora trilineata*, *Crepidula fornicata*, *Lunatia triseriata*, *Mamma immaculata*, and several species of *Bela*.

The fauna of the region north of Pictou, between the west coast of Cape Breton and the east of Prince Edward Island, is essentially of an Acadian type. To the north, northwest, and west of Cape Breton, the deep water assemblage has probably an Arctic character.

In the marine slip at Pictou, I collected specimens of *Teredo navalis* burrowing into the black birch of which the roller frames of the cradle are composed. At Souris, (Prince Edward I.), the common periwinkle of England (*Littorina littorea*) was plentiful, and it was subsequently observed at Charlottetown. An *Argulus*, closely allied to *A. Alosæ* of Gould, if not identical with it, was taken off Pictou Island, in towing nets, attached to *Gasterosteus biaculeatus?* and other small fishes. *Idotea irrorata* Say, was common on the surface at the same place, and was subsequently obtained at Shediac Bay, and elsewhere. On the shores of the Magdalen Islands it is tolerably common.

Cruise 4.—In the last cruise we endeavored to explore both sides of Northumberland Straits, and dredged from Pictou as far to the northwest as Miramichi Bay. Leaving Pictou on the 19th of August, we first dredged a little to the N.N.W. of Pictou Island, and were then compelled by stormy weather to take shelter in Shediac Bay. Being detained at Point du Chêne for two days, we availed ourselves of the opportunity to examine the oyster beds of Shediac Bay. On these beds, from low water mark down to three fathoms, the following species were met with:

CRUSTACEA.

Cancer irroratus *Say.*
Crangon vulgaris *Fab.*
†Gammarus ornatus *Edw.*
Idotea irrorata *Say.*

Mollusca.

Ostrea borealis *Lam.*
O. Virginiana *Lister.*
Mytilus edulis *Linn.*
Modiola modiolus *Linn.*
Mercenaria violacea *Schum.*
Gemma Tottenii *St.*
Callista convexa *Say.*
Petricola pholadiformis *Lam.* and var. dactylus.
Mactra solidissima *Chemn.*
Mya arenaria.
" truncata.
Angulus tener *Say.*
Thracia Conradi (fine and frequent).
Pandora trilineata *Say.*
Solen ensis, v. Americana.
Teredo, sp. (in a spruce log).
Haminea solitaria *Say.*
Cylichna pertenuis *Migh.*
Acmœa alveus *Conrad.*
Crepidula fornicata *Linn.*
" unguiformis *Lam.*
Paludinella minuta.
Odostomia trifida *Totten.*
Turbonilla interrupta *Totten.*
Lunatia heros *Say.*
Bittium nigrum *Totten.*
Nassa obsoleta *Say.*
" trivittata *Say.*
Astyris lunata *Say.*

Echinodermata.

Asterias vulgaris *St.*
Cribella sanguinolenta.
Echinarachnius parma.
Echinus Drobachiensis.
Caudina arenata (*Gould*).

Leaving Shediac by daybreak on the 22d of August, we dredged from that place to the Egmont Bank, and stood back again to the south shore the same evening. The Egmont Bank is a small rocky patch, situated between Shediac Bay and Cape Egmont, Prince Edward Island. The depth on it is less than ten fathoms, and the bottom consists of coarse sand and stones, the latter covered with *Laminariæ* and smaller algæ, and perforated by *Petricola pholadiformis.* Annelids are numerous in the sand, from which also about twelve species of shells were collected. Early the next morning (August 23d), we stood over to the Prince Edward Island side, and dredged along the outside of Bedeque Bay, from off St. Jacques to a little to the south of Sea Cow Head. In the afternoon a falling barometer indicating the imminent approach of a storm, we made for Charlottetown, and reached there only just in time to weather out the memorable gale of the 24th of August. We subsequently managed to dredge in Hillsborough Bay; also, on the opposite shore, off Pugwash Harbor, N. S., and off Shediac, Buctouche and Richibucto, in New Brunswick, and on the 9th of September I left the schooner and proceeded home. On the Prince Edward Island side of Northumberland Straits proper, the bottom is usually a red (Triassic) clayey mud, while on the New Brunswick side it is generally sandy. The fauna of the Straits is of a decidedly Acadian type. A few sponges, hydroids and crustaceans collected here have yet to be studied. The annelids are fine and frequent, but the echinoderms are all very common species. At depths of more than four fathoms, in Northumberland Straits, the following species were collected:

CRUSTACEA.

Homarus Americanus (fry.)
Crangon vulgaris.
†Hippolyte pusiola _Kr._
†Diastylis lucifera.
† " sculpta? _G. O. Sars._
†Pontoporcia femorata.
†Unciola irrorata _Say._
†Amphithoe, _sp._
†Ptilocheirus pinguis.
†Melphidippa, _sp._
†Idotea phosphorea _Harger._

TUNICATA.

*Eugyra pilularis _V._
Pelonaia arenifera _St._

MOLLUSCA.

Pecten tenuicostatus _Migh._
Yoldia limatula _Say._
" sapotilla _Gould._
Nucula delphinodonta _Migh._
Astarte undata _Gould._
Cyprina Islandica _Linn._
Cardium pinnulatum _Con._
Callista convexa _Say._
Petricola pholadiformis _Lam._
Mactra lateralis _Say._
Pandora trilineata _Say._
Turbonilla interrupta _Totten._
Lunatia triseriata _Say._
Nassa trivittata _Say._
Buccinum undatum _Linn._
Sipho pygmæus _Gld._
Bela cancellata _Migh._

ON THE POST-PLIOCENE FORMATION NEAR BATHURST, NEW BRUNSWICK.

By Rev. C. H. Paisley, M.A.

In the Post-pliocene formation of the County Gloucester, quite widely distributed at the mouths of its rivers, and at many places on the sea coast, there is usually very little difficulty in observing the presence of the three members of the group, viz.:

Boulder Clay,
Leda Clay,
Saxicava Sand.

All three, so far as examination extends, are usually, if not invariably, present in well-defined superposition, and that part of the group which corresponds with the upper portion of the Leda clay and the lower portion of the Saxicava sand is generally fossiliferous. At two places in the neighbourhood of Bathurst, on the line of the Intercolonial Railway, there are good exposures of this formation. The one is about 2½ miles distant on the left bank of the Tattagouche River (*vid. Naturalist*, No. 1, Vol. vii. p. 41), and the other about ¾ of a mile distant from St. Peter's Village.

With regard to the general characteristics of the Post-pliocene in these localities, it may be said that they are similar in very many respects to those of the same formation on the St. Lawrence, as described by Dr. Dawson, and at St. John, as described by Mr. Matthew.

The boulder clay usually presents a banded appearance of red alternating with a bluish tint, and in some parts can be observed obscure traces of stratification. It is scantily fossiliferous, containing occasional valves of *Mya arenaria*, *Natica* &c., so much decomposed that they cannot be removed. The boulders are, in some places, numerous, not however so much so as to give a very marked character to the beds, which are of unequal thickness, but, in a general way, thin out towards the present sea shore. Some of the boulders must have been brought a considerable distance, although all but the softer variety are angular and wedge-shaped, not having undergone much wear in transportation. Most of them are very dissimilar to the rocks of the neighbouring formations; but some have their representatives in Restigouche, near Dalhousie.

The surface of this formation, which seldom attains a greater elevation than about 150 feet, is marked by a good deal of inequality.

The Leda clay is generally, when wet, of a reddish hue, drying into a darker but less decided tint, and may possibly have been derived, in part, from the red Sub-carboniferous rocks in the neighbourhood. It varies a great deal in thickness, and through it there are distributed thin layers of sand that maintain a uniform thickness, shewing that they must have been deposited in a gently moving current, or in some quiet and protected place. Indeed all through the middle and lower part of this bed the fossils are so well preserved and so little mutilated, that they must have been deposited very gently. *Nucula*, which is quite abundant, is extremely well preserved with the valves united, epidermis fresh looking and perfect, and the teeth whole. *Mya* also is well preserved, retaining quite frequently the epidermis, and, in this respect, contrasts with specimens found in the fossiliferous bed constituting the lower part of the Saxicava sand and the upper part of the Leda clay. I have once or twice found what would seem to be cracks or holes 2—3 feet deep in this bed almost filled with *Nucula tenuis* and *N. expansa*, with an occasional *Cryptodon*, *Natica*, *Macoma*, and *Balanus*. So abundant were the *Nuculæ* that a pint might be readily washed out of a shovel full of the clay, which was much blackened by the decomposition of animal matter. What was the origin of these holes and why they should be filled so abundantly with *Nuculæ* to the almost entire exclusion of other shells, I cannot conjecture.

The Saxicava sand is also very irregular as to thickness, and terminates, in most places, abruptly on the uneven surface of the Leda clay. It would seem that before the deposition of the sand, currents or some other agents grooved and hollowed out the underlying clay, and that these irregularities were filled up by the sand, which seems to have been deposited by somewhat violent currents in unquiet waters. More rarely, however, instead of the one formation passing abruptly into the other, they gradually merge, so that it cannot be said where the one ends and the other begins. The surface of the Saxicava sand is even more irregular than that of the Leda clay, either from the inequalities of its deposition or from denuding agents at work afterwards, or from a combination of both. Viewing the Post-pliocene in this locality as a whole in its resemblance to that of the St. Lawrence on the one side and to that of St. John on the other, we may, perhaps, regard it, as suggested by Mr. Matthew, as a connecting link between the two. I may sum up the fossils thus far obtained in the following list :

RADIATA.

Echinoidea.—*Euryechinus Drobachiensis.*

MOLLUSCA.

Lamellibranchiata.—*Saxicava rugosa* (et var. *arctica*) ; *Mya truncata* (var. *Uddevallensis*) ; *M. arenaria* (et *juvenis*) ; *Macoma Grœnlandica ; M. calcarea ; Aphrodite Grœnlandica* (et *juvenis*) ; *Cryptodon Gouldii ; Mytilus edulis* ; *Nucula tenuis ; N. expansa ; Leda pernula ; L. glacialis , L. minuta ; L. limatula.**

Gasteropoda.—*Bela turricula* (Gould); *Trophon scalariforme ; Natica clausa ;*† *Buccinum undatum ; B. cyaneum ; B. Grœnlandicum ; B. tenue ; Fusus tornatus.*

ARTICULATA.

Annulata.—2 varieties of *Spirorbis.*

Besides these I have obtained the following plant remains: *Zostera marina*, rhizomata of *Equisetum*, and fragments of grasses.

Further examination, by more skilled observers, would doubtless be fruitful of greater results, but what has been done may serve to direct attention to a locality hitherto uninvestigated.

Before closing let me state that I am much indebted to Dr. Dawson and Mr. Matthew for assistance in the determination of the fossils.

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* *Ostrea* was found by a workman on the railway, and afterwards shewn to me. He assured me that he himself picked it out about 16 ft. (I think) below the surface. Lest, however, there should be some doubt as to its not having fallen into the cut from the surface, I have not inserted it in the list, although I think it might be inserted with a question after it.

† *Natica heros.* I have seen a specimen of this shell said to have been obtained here, but I have not inserted it in the list, because I did not find it myself. It has been found in the next county.

TWO NEW FOSSIL COCKROACHES FROM THE CARBONIFEROUS OF CAPE BRETON.

By Samuel H. Scudder.

Through the kindness of Dr. J. W. Dawson, I have been enabled to study two fossil cockroaches, from the collections made by R. Brown, Esq., F.G.S., in the carboniferous deposits of the Sydney coal-field, Cape Breton, and placed in Dr. Dawson's hands for determination of the fossil plants. When more species and specimens of this ancient group shall have been discovered, I hope to undertake a revision of the whole, meanwhile describing new forms under the generic name *Blattina*, a somewhat heterogeneous group to which most fossil cockroaches have, for convenience' sake, been referred.

Three fossil cockroaches have already been described from the carboniferous formations of America: *Blattina venusta*, Lesq., from Arkansas, *Archimulacris acadicus*, Scudd., from Pictou, N.S., and *Mylacris anthracophilus*, Scudd., from Illinois. With the exception of the last, where the pronotum is also preserved, each of these fossils is represented by a single upper wing. The two additional species now described are also similarly represented; thus every specimen yet discovered in America is referable to a distinct species.

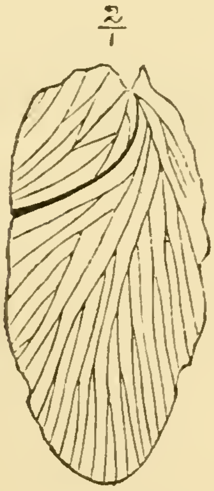

Fig. 1. *Blattina Bretonensis*, Scudd.

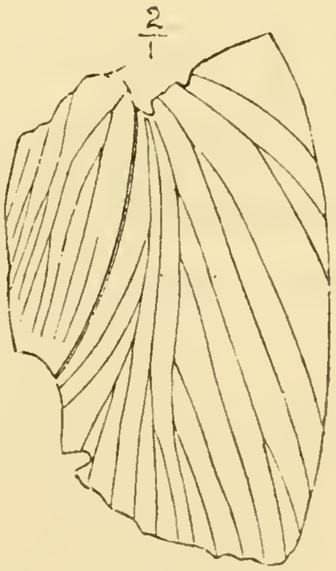

Fig. 2. *Blattina Heeri*, Scudd.

Blattina Bretonensis, nov. sp. This is a well preserved and very nearly complete upper wing of the right side, its length

16.35$^{\mathrm{mm.}}$ and its extreme breadth 7.2$^{\mathrm{mm.}}$ The form of the wing is an oblong, pretty regular oval, the apical portion a little produced. The anal nervure is deeply impressed, strongly curved, especially just before its middle, where the wing was somewhat convex, and terminates before the middle of the basal two-thirds of the posterior border. The other nervures and their branches are very delicate, and the branches equidistant and rather closely crowded; the spaces between them are wholly unbroken by any cross-nervules, and the surface of the wing appears to have been smooth in life. (Fig. 1.)

Blattina Heeri, nov. sp. This is also represented by a right upper wing, but it is not so perfect as the preceding; the whole of the apex, and the outer half of the posterior border is lost. The length of the fragment is 21$^{\mathrm{mm.}}$; probably the entire wing would have been two or three millimetres longer; the width of the wing, just before the middle, is 11.8$^{\mathrm{mm.}}$ The wing is proportionately broader than in the preceding species and less convex, and the apex is probably less extended, but otherwise it has much the same form. The anal nervure is deeply impressed only over its basal half, and is gently curved, terminating doubtless at about the middle of the posterior border; the other nervures and their branches are rather distinctly impressed, somewhat distant and regular; the spaces between are transversely and very faintly wrinkled, rather than provided with cross-nervules; the surface is nevertheless pretty smooth; the costal border is very delicately marginate. (Fig. 2.)

This species is named in honor of Professor Oswald Heer of Zurich, who has laid the foundation of our present knowledge of fossil insects.

Both of the above specimens are on dark gray shale, and are associated with leaves of *Sphenophyllum* and ferns.

Cambridge, April 24, 1874.

NATURAL HISTORY SOCIETY.

PROCEEDINGS FOR THE SESSION 1873–74.

MONTHLY MEETINGS.

1st Monthly Meeting, held Oct. 27th, 1873.

A paper on *Cornus Suecica* was read by Principal Dawson.

After some remarks on the distribution of this and the related species, in Canada, by Dr. John Bell and other members, Dr. P. P. Carpenter gave a verbal account of the life and labours of the late Mr. R. McAndrew, of London, as a conchologist.

Further observations on this topic were made by the President and Rec. Secretary, and Dr. Carpenter was requested to prepare an obituary notice for publication in this journal.*

2nd Monthly Meeting, held Nov. 24th, 1873.

R. C. Chisholm and Albert E. Linchant were elected members of the Society.

The Recording Secretary read a paper "On a collection of Himalayan birds recently presented to the Society by Major G. E. Bulger F.R.G.S., Z.S., L.S."

On motion of C. Robb, seconded by G. Barnston, it was unanimously resolved :

"That the special thanks of the Society be voted to Major Bulger for his liberal donation to its museum."

Principal Dawson read a letter from the Rev. Mr. Harvey (of St. John's, Newfoundland) giving an account of a gigantic cuttle-fish recently captured at Conception Bay.

3rd Monthly Meeting, held Jan 26th, 1874.

Resolutions of condolence with the family of the late Dr. C. Smallwood were submitted and adopted.

Messrs. Kenneth McLea, W. Barnston, W. Robertson and Dr. A. A. Browne were elected resident members.

Mr. A. R. C. Selwyn then read a paper entitled "Notes on a journey through the N. W. Territory, from Manitoba to Rocky Mountain House."†

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* See Vol. vii. p. 227. † Ibid, p. 193.

A discussion ensued, in which Principal Dawson, G. M. Dawson, Prof. Bell, Prof. Darey and other members took part.

4th Monthly Meeting, held Feb. 23rd, 1874.

A paper on the Lignite Tertiaries of the West, was read by Mr. G. M. Dawson.*

Remarks on this subject were made by Principal, Dawson Mr. Selwyn, Mr. Miller, C. Robb, and other persons present.

5th Monthly Meeting, held March 30th, 1874.

Messrs. Arnold G. Fenwick, James Gardner, Charles Garth, W. F. Gatling, G. R. Grant, R. A. Lindsay, W. Rhind and James Williamson were elected members of the Society. Miss Cordner, Mrs. Mercer, Mrs. Molson, Miss Symmers, and Miss Smith were elected Associate Members.

A paper on the Geology of Arisaig N. S., by Mr. T. C. Weston, was read by the Recording Secretary.

Mr. Whiteaves made a communication on some results obtained during a recent deep sea dredging expedition round Prince Edward Island.

6th Monthly Meeting, held April 27th, 1874.

Messrs F. E. Grafton, S. P. Rowell, and J. J. Rowan Spong, were elected resident members.

Mrs. Lewis and Miss Julia Sanborn were also elected associate members.

Dr. B. J. Harrington then read a paper entitled "Notes on some of the Montreal Trap Dykes and the Minerals which they contain."

After some remarks on this topic by the President, the meeting was adjourned.

SOMERVILLE LECTURES.

The following is a list of the free lectures of this course, with the dates at which they were delivered.

1. Feb. 5th, 1874.—The Ancient Geography of North America, by Dr. T. Sterry Hunt, F.R.S.

2. Feb. 19th, 1874.—Geological Facts as to Primitive Man, by Principal Dawson, L.L.D., F.R.S.

3. Feb. 19th, 1874.—A Summer on the Plains, by Prof. R. Bell, F.G.S.

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* See Vol. vii. p. 241.

4. Feb. 26th, 1874.—Oyster Culture, by Dr. P. P. Carpenter.

5. March 5th, 1874.—The Tooth of Time, by C. Robb.

6. March 12th, 1874.—Sponges, by G. T. Kennedy, M.A.

7. March 19th, 1874.—The Early Wanderings of the Anglo-Saxon Race, by Rev. Canon Baldwin, M.A.

8. March 26th, 1874.—Advanced Scientists, by Dr. Hingston.

DONATIONS TO THE MUSEUM.

From Major G. E. Bulger, F.R.G.S., L.S., Z.S.—60 fine specimens of the birds of the Himalayas.

Yale college New Haven, per. S. I. Smith.—45 named species of Marine Crustacea from the Northern United States.

Yale College, New Haven, per Prof. A. E. Verrill.—An extensive series of named Marine Invertebrates from the dredgings under the auspices of the U. S. Fish Commission.

Mons. A. Le Chevallier.—Skin of the Java Ant-Thrush.
" " " Brown Pelican, from Florida.
" " " Frigate " " "
" " " Painted Quail.
" " " Eggs of 73 species of N. American Birds.
" " " Asterid from Florida.

Prof. R. Bell.—Specimen of the American Badger, from the Plains of the Saskatchewan.

H. Vennor Esq.—Fine example of the American Wolf, from Levant Township, back of Hull, Ont.

G. Barnston, Esq. Fossil shells from Albany River, and seed-pod of a leguminous plant from Ceylon.

" " Specimen of the Magpie Robin (*Copsychus saularis*) and Bengal Ant-Thrush (*Pitta Bengalensis*), both from Ceylon.

C. Robb, Esq.—3 Specimens of marine sponges from Cape Breton.

F. B. Caulfield, Esq.—26 Named species of Canadian Coleoptera and one of Lepidoptera.

A. H. Foord Esq., F.G.S.—Two models of Greenland Harpoons.

A. R. C. Selwyn, Esq. F.R.S.—Specimens of *Tellina secta* Con., and *Coronula diadema*, from Vancouver Island.

Mr. W. H. Couper.—Pair of *Papilio brevicauda* Saunders (*P. Anticostiensis* Strecker.)
" " " *Pieris* (*Ganoris*) *borealis*.
" " " *Melitœa tharos.* (Northern variety)
" " " *Glaucopysyche Couperi* Grote.

S. J. Lyman, Esq.—An American Bittern.

Mr. S. W. Passmore.—An American Coot.

Mrs. Maitland.—Various objects found at Tadousac some 12 years ago, supposed to be relics of the old Jesuit mission at that place.

The Smithsonian Institute, Washington.—14 Skins of N. American Rodents.

DONATIONS TO THE LIBRARY.

From the Trustees of the British Museum.—Catalogue of Hemiptera Heteroptera, Part 8.

" " " Hand list of Shield reptiles.

" " " Hand list of the Edentate, Thick-skinned, and Ruminant Mammals in the British Museum.

The Director of the Geological Survey of Canada.—Report of Progress for 1872–73.

From the U. S. Geological Survey of the Territories.—Contribution to the Extinct Vertebrate Fauna of the Western Territories By Joseph Leidy M.D. 4to with 37 plates.

Acrididæ of North America. By Cyrus Thomas, Ph. D. 4to., with one Plate.

From F. V. Hayden, U. S. Geologist.—First, second and third reports of the U. S. Geological Survey of the Territories for the years 1867, 1868, and 1869. 8vo.

United States Geological Survey of Montana, Idaho, Wyoming, and Utah. Report for 1872. By F V. Hayden.

From the Author.—The Silurian Brachiopoda of the Pentland Hills. By Thomas Davidson. 4to., 3 plates.

Regents of the State of New York.—New York Meteorology. 1850–63. Second series by F. B. Hough.

Annals of the Dudley Observatory Vol. 2. Albany. 1871.

55th Annual Report of the Trustees of the New York State Library. Albany, 1873.

24th Report of the New York State Museum of Natural History. Albany, 1872.

Manual for the use of the Legislature of the State of New York Albany, 1871.

Department of Public Instruction, Quebec.—Report of the Minister of Public Instruction for the Province of Quebec for 1872 and part of 1873.

From the Author.—On the Classification of the Cambrian and Silurian Rocks. By Henry Hicks, F.G.S. 8vo Pamphlet.

From the Author.—The Liberal Education of the Nineteenth Century. By Prof. W. Atkinson. 8vo Pamphlet.

From the Author.—Notes of a tour from Bangalore to Calcutta, thence to Delhi and subsequently to British Sikkim, during the early part of 1867. By Major G. E. Bulger, F.L.S., F.R.G.S., C.M.Z.S.

ANNUAL MEETING,

Held May 18th, 1874.

The minutes of the last annual meeting having been read by the Recording Sectetary, the following address was delivered by the President, Principal Dawson, LL.D., F.R.S.

ANNUAL ADDRESS.

The scientific work of this Society in the year which closes to-night, is not so remarkable for its variety as for the interest and importance of the subjects to which it relates. A list of the papers read is appended to this address;* but I shall confine myself principally to two subjects embraced in their scope. One is the bearing of the dredging operations of our colleague, Mr. Whiteaves, on the Post-pliocene Geology of Canada, in connection with other oceanic and geological researches. The second is the growth of our information as to the geological structure of those great plains of the West, whose profitable occupancy is now so important a problem for our statesmen.

Mr. Whiteaves in the past summer was chiefly occupied with the exploration of the great southern Bay of the Gulf of St. Lawrence, a basin of shallow water nearly semicircular in form, and in which is set the beautiful Island of Prince Edward. It is protected to some extent by the encompassing land, by its limited depth, and by the islands and shoals stretching across its mouth, from the influence of those cold northern currents which pervade all the middle and northern parts of the Gulf, and give to its fauna an almost Arctic character: it thus forms a peculiar and exceptional zoological province. The marine animals of Northumberland Strait were those with which I was myself most familiar in early youth, and I still possess many drawings of the more minute forms, made under the microscope for my amusement, before I had received any scientific training in natural history. In my cabinet there has been for the last thirty years a nearly complete representation of its mollusks, and I was even then aware from the observations of Gould and others in New England, of the specially southern character of this group of animals, though at that time I had no means of publishing my observations, and the importance of these peculiarities of distribution had scarcely dawned upon the minds of geologists. In later years, however, Mr. Whiteaves and Prof. Verrill have, in connection with the dredging operations carried on in the interest of our fisheries, more fully worked up the relations of these faunæ, and we are now in a position to speak with some certainty of the facts, and to appreciate their significance.

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* See preceding pages 273, 274.

If we draw a straight line from the northern end of Cape Breton through the Magdalen Islands to the mouth of the Bay des Chaleurs, we have to the southward an extensive semicircular Bay, 200 miles in diameter, which we may call the great *Acadian Bay*, and on the north the larger and deeper triangular area of the Gulf of St. Lawrence. This Acadian Bay is a sort of gigantic warm-water aquarium, sheltered, except in a few isolated banks which have been pointed out by Mr. Whiteaves, from the cold waters of the Gulf, and which the bather feels quite warm in comparison with the frigid and often not very limped liquid with which we are fain to be content in the Lower St. Lawrence. It also affords to the more delicate marine animals a more congenial habitat than they can find in the Bay of Fundy or even on the coast of Maine, unless in a few sheltered spots, some of which have been explored by Prof. Verrill. It is true that in winter the whole Acadian Bay is encumbered with floating ice, partly produced on its own shores and partly drifted from the north; but in summer the action of the sun upon its surface, the warm air flowing over it from the neighbouring land, and the ocean water brought in by the Strait of Canso, rapidly raise its temperature, and it retains this elevated temperature till late in autumn. Hence the character of its fauna, which is indicated by the fact that many species of mollusks whose headquarters are south of Cape Cod, flourish and abound in its waters. Among these are the common oyster, which is especially abundant on the coasts of Prince Edward Island and northern New Brunswick, the Quahog or Wampum shell, the *Petricola pholadiformis*, which along with *Zirfea crispata*, burrows everywhere in the soft sandstones and shales; the beautiful *Modiola plicatula* forming dense mussel-banks in the sheltered coves and estuaries; *Cytherea (Callista) convexa; Cochlodesma leana* and *Cummingia tellinoides; Crepidula fornicata*, the slipper-limpet, and its variety *unguiformis*, swarming especially in the oyster beds; *Nassa obsoleta* and *Buccinum cinereum*, with many others of similar southern distribution.

Nor is the fauna so very meagre as might be supposed. My own collections from Northumberland Strait include about 50 species of mollusks, and some not possessed by me have been found by Mr. Whiteaves. Some of these, it is true, are northern forms, but the majority are of New England species.

The causes of this exceptional condition of things in the Acadian Bay carry us far back in geological time. The area now constituting the Gulf of St. Lawrence seems to have been exempt from the great movements of plication and elevation which produced the hilly and metamorphic ridges of the east coast of America. These all die out and disappear as they approach its southern shore. The tranquil and gradual passage from the Lower to the Upper Silurian ascertained by Billings in the rocks of Anticosti, and unique in North America, furnishes an excellent illustration of this. In the Carboniferous period the Gulf of St. Lawrence was a sea area as now, but with wider limits, and at that time its southern part was much filled up with sandy and muddy detritus, and its margins were invaded by beds and dykes of trappean rocks. In the Triassic age the red sandstones of that period were extensively deposited in the Acadian Bay, and in part have been raised out of the water in Prince Edward Island, while the whole Bay was shallowed and in part cut off from the remainder of the Gulf by the elevation of ridges of Lower Carboniferous rocks across its mouth. In the Post-pliocene period, that which immediately precedes our own modern age, as I have elsewhere shown,* there was great subsidence of this region, accompanied by a cold climate, and boulders of Laurentian rocks were drifted from Labrador and deposited on Prince Edward Island and Nova Scotia, while the southern currents flowing up what is now the Bay of Fundy, drifted stones from the hills of New Brunswick to Prince Edward Island. At this time the Acadian Bay enjoyed no exemption from the general cold, for at Campbelltown, in Prince Edward Island, and at Bathurst in New Brunswick, we find in the clays and gravels the northern shells generally characteristic of the Post-pliocene; though perhaps the lists given by Mr. Matthew for St. John and by Mr. Paisley for the vicinity of Bathurst, may be held to shew some slight mitigation of the Arctic conditions as compared with the typical deposits in the St. Lawrence valley. Since that time the land has gradually been raised out of the waters, and with this elevation the southern or Acadian fauna has crept northward and established itself around Prince Edward Island, as the Acadian Bay attained its present form and conditions. But how is it that this fauna is now isolated, and that intervening colder waters separate it from that of southern New England. Verrill regards this colony of the Acadian Bay as indicating a warmer climate intervening between the cold Post-pliocene period and the present, and he seems to think that this may either have been coincident with a lower level of the land sufficient to establish a shallow water channel, connecting the Bay of Fundy with the Gulf, or with a higher level raising many of the banks on the coast of Nova Scotia out of water. Geological facts, which I have illustrated in my Acadian Geology, indicate the latter as the probable cause. We know that the eastern coast of America has in modern times been gradually subsiding. Further, the remarkable submarine forests in the Bay of Fundy show that within a time not sufficient to produce the decay of pine wood, this depression has taken place to the extent of at least 40 feet, and probably to 60 feet or more.* We have thus direct geological evidence of a former higher condition of the land, which may when at its maximum have greatly exceeded that above indicated, since we cannot trace the submarine forests as far below the sea level as they actually extend. The effect of such an elevation of the land would be not only a general shallowing of the water in the Bay of Fundy and the Acadian Bay, and an elevation of its temperature both by this and by the greater amount of neighbouring land, but as Prof. Verrill well states, it would also raise the banks off the Nova Scotia coast, and extending south from Newfoundland, so as to throw the Arctic current further from the shore and warm the water along the coasts of Nova Scotia and Northern New England. In these circumstances the marine animals of Southern New England might readily extend themselves all around the coasts of Nova Scotia and Cape Breton, and occupy the Acadian Bay. The modern subsidence of the land would produce a relapse toward the glacial age, the Arctic currents would be allowed to cleave more closely to the coast, and the inhabitants of the Acadian Bay would gradually become isolated, while the northern animals of Labrador would work their way southward.

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* Notes on Post-pliocene of Canada, *Canadian Naturalist*, 1872

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* Acadian Geology, p. 29.

Various modern indications point to the same conclusions. Verrill has described little colonies of southern species still surviving on the coast of Maine. There are also dead shells of these species in mud banks, in places where they are now extinct. He also states that the remains in shell-heaps left by the Indians indicate that even within the period of their occupancy some of these species existed in places where they are not now found. Willis has catalogued some of these species from the deep bays and inlets on the Atlantic coast of Nova Scotia, and has shown that some of them still exist on the Sable Island banks.*

Whiteaves finds in the Bradelle and Orphan bank littoral species remote from the present shores, and indicating a time when these banks were islands, which have been submerged by subsidence, aided no doubt by the action of the waves.

It would thus appear that the colonisation of the Acadian Bay with southern forms belongs to the modern period, but that it has already passed its culmination, and the recent subsidence of the coast has no doubt limited the range of these animals, and is probably still favouring the gradual inroads of the Arctic fauna from the north, which, should this subsidence go on, will creep slowly back to reoccupy the ground which it once held in the Post-pliocene time.

Such peculiarities of distribution serve to show the effects of even comparatively small changes of level upon climate, and upon the distribution of life, and to confirm the same lesson of caution in our interpretation of local diversities of fossils, which geologists have been lately learning from the distribution of cold and warm currents in the Atlantic. Another lesson which they teach is the wonderful fixity of species. Continents rise and sink, climates change, islands are devoured by the sea or restored again from its depths; marine animals are locally exterminated and are enabled in the course of long ages to regain their lost abodes; yet they remain ever the same, and even in their varietal forms perfectly resemble those remote ancestors which are separated from them by a vast lapse of ages and by many physical revolutions. This truth which I have already deduced from the Post-pliocene fauna of the St. Lawrence Valley, is equally taught by the molluscs of the Acadian Bay, and by their Arctic relatives returning after long absence to claim their old homes.

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* Acadian Geology, p. 37.

Still another lesson may be learned here. It appears that our present climate is separated from that of the glacial age by one somewhat warmer, which was coincident with an elevated condition of the land. Applied to Europe, as it might easily be, this fact shows the futility of attempting to establish a later glacial period between the Post-pliocone and the present, in the manner attempted, as I must think on the slenderest possible grounds, by Prof. Geikie in his late work "The Great Ice Age."

The grandeur of those physical changes which have occurred since the present marine animals came into being, is well illustrated by some other facts to which our attention has been directed. Recent excavations in the Montreal mountain have enabled Mr. Kennedy to observe deposits of Post-pliocene marine shells at a still higher level than that of the old beach above Cote des Neiges, which was so long ago described by Sir Wm. Logan and Sir Charles Lyell. The new positions are stated to be 534 feet above the sea. Let us place this fact along with that recorded by Prof. Bell in the Report of the Geological Survey for 1870-71, of the occurrence of these same shells on the high lands north of Lake Superior, at a height which, taking the average of his measurements, is 547 feet above the sea level. Let us further note the fact, that in the hills behind Murray Bay and at Les Eboulements I have recorded the occurrence of these remains at the height of at least 600 feet. We have then before us the evidence of the submergence of a portion of the North American continent at least 1000 miles in length and 400 miles in breadth to a depth of more than a hundred fathoms, and its re-elevation, without any appreciable change in molluscan life.

Another important and impressive fact in this connection has recently been brought out by Dr. Hunt in a paper on the Geology of the South-eastern Appalachians.* He there shows that in these mountains, which lie to the south of the region of the great Post-pliocene submergence, the gneissose rocks have been decomposed in place to enormous depths, without any of the material being removed—a most striking contrast to the generally bare and scraped condition of similar rocks in the north. I was struck very much with this fact several years ago, when, under the guidance of my friend Dr. Tyson, I had an opportunity of examining the crystalline rocks near Baltimore, and I have also in my notes on the Post-pliocene of Canada, pointed out that in some places, as at Les Eboulements and on the southern side of our own mountain, where the rocks have been sheltered from the northern currents, extensive evidence of old sub-aerial disintegration may be seen.

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* Proceedings American Association, 1873.

It is most instructive to compare in connection with this point the condition of the Silurian rocks on the north-east and south sides of the Montreal mountain. On the former they show no signs of sub-aerial waste, but are polished and striated in the most perfect manner. The striae are N.E. and S.W., or in the direction of the river valley, and that the force producing them acted from the N.E. is shewn by the manner in which projecting trap dykes are ground on the N. E. side and left rough on the opposite one. The striae vary in direction, having evidently been produced by many successive impacts of heavy bodies moving from the north-east but not always in precisely the same lines. It seems absolutely impossible that anything except floating ice running from the N. E. or against the present drainage of the country could have produced these striations.* On the limestone slopes which front the mountain, all is different. In the vicinity of the reservoirs, for example, the coarse earthy limestone, where it has been protected by hard trap dykes, is in many places decomposed to a great depth, and shows no signs of glacial action.

What does this teach us? The same truth which we learn from the wholesale transference of boulders, sand and clay to the south-west over our country, namely, that *the great agent in denuding it of all its decomposed and broken rock has been the Arctic current passing over it when submerged.* The boulders which have been swept away from our Laurentian hills are merely the harder and less decomposed parts of rocks which had been disintegrated long before the glacial period, but became the prey of water and ice when the land was submerged. Geologists will not learn to understand fully the Post-pliocene period, until they are prepared to admit that the power of the heavy Arctic currents passing over the submerged land and carrying with them their burden of ice, is vastly greater as an agent of denudation than either the rivers or glaciers. Nor must we confine this to the Post-pliocene period. Prof. Hall has shewn that the whole of the vast thickness of the Palæozoic rocks of the Appalachians may be attributed to the carrying power of the same currents which are now piling up banks of Arctic sand and stones along the American coast. Nay more, the history of the land of the Northern Hemisphere throughout geological time has been that of a series of elevations and depressions or gigantic pulsations of the earth's crust, so regular that we cannot hesitate in referring them to some constantly operating law. Every elevation exposed the land to sub-aerial disintegration. Every subsidence scraped and peeled it by the action of the Arctic currents, and thus the carriage of material and the growth of the continents have ever been to the south-west. I cannot leave this subject without according to Dr. Carpenter much credit for contending as he has done for the reality, power, and true causes of these great sub-oceanic rivers, which have played and are playing so important parts as geological agents, that without them it is impossible to account either for the Palæozoic deposits or the Post-pliocene deposits of our North American continent.

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* I saw last autumn on St. Helen's Island a very instructive instance of striation on Utica shale produced by the ice-shove of the previous spring. This was in the direction of the river valley, but the evidence of the force acting from the south-west was plain, while a miniature moraine of rock fragments in advance of the markings shewed the agent by which they had been effected.

But it is time to turn to the second topic which I have marked out for myself in this discourse. In the past summer three lines of geological reconnaissance have been pushed out from the Laurentian and Huronian country of Lake Superior over the plains of Manitoba. One of these, under Mr. Selwyn, followed the line of the North Saskatchewan. The second was that of Prof. Bell on the south branch of the same river and its tributaries. The third was that of Mr. G. M. Dawson on the 49th parallel. All of these have been brought under the notice of this Society in the course of the winter. This great western plain presents first a wide expanse of Cretaceous rocks, apparently not highly fossiliferous and not well exposed, but containing some limestone layers rich in Foraminifera and Coccoliths precisely similar to those of the English chalk. Some of these have been described by Mr. Dawson in our Journal. This is succeeded by vast estuarine and lacustrine deposits of clay and sand, holding brackish-water and fresh-water shells, and beds of lignite with abundant plant remains. The general geological history of these great prairie lands is thus as plain and simple as their own superficial features. First, we have a great Cretaceous Mediterranean, extending from the Gulf of Mexico perhaps to the Arctic sea. Then we have this dried up into estuaries, lakes and marshes, and becoming clothed with a rich vegetation similar in general character to that of the west coast at present, and indicating a mild and genial climate. Then we have the great Post-pliocene subsidence, with its trains of gravel and ice-borne boulders; and lastly the re-elevation into the prairie lands of to-day, with perhaps an intervening age of modern forests. The final results are a vast expanse of fertile soil, and great stores of mineral fuel, which may one day make these now lone lands the seats of extensive manufacturing industries. Detailed reports of the explorations of the past year are in progress, and will greatly increase our precise and definite knowledge of regions which have hitherto been known to us principally through the vague impressions of unscientific travellers.

Simple though the structure of these Western regions is, it has already given rise to controversies, more especially with reference to the age of the plants and animals whose remains have been found in these formations south of the United States boundary. In looking over these controversies, I am inclined in the first place to believe that we have in the West a gradual passage from the Cretaceous to the Tertiary beds, and that these last may scarcely admit of a definite division into Eocene and Miocene. We may thus have in these regions the means of bridging over what has been one of the widest gaps in the earth's history and of repairing one of the greatest imperfections in the geological record.

Physically the change from the Cretaceous to the Tertiary was one of continental elevation—drying up the oceanic waters in which the marine animals of the Cretaceous lived, and affording constantly increasing scope for land animals and plants. Thus it must have happened that the marine Cretaceous animals disappeared first from the high lands and lingered longest in the valleys, while the life of the Tertiary came on first in the hills and was more tardily introduced on the plains. Hence it has arisen that many beds which Meek and Cope regard as Cretaceous on the evidence of animal fossils, Newberry and Lesquereux regard as Tertiary on the evidence of fossil plants. This depends on the general law that in times of continental elevation newer productions of the land are mixed with more antique inhabitants of the sea; while on the contrary in times of subsidence older land creatures are liable to be mixed with newer products of the sea. Thus in Vancouver's Island plants which Heer at first regarded as Miocene have been washed down into waters in which Cretaceous shell-fishes still swarmed. Thus Cope maintains that the lignite-bearing or Fort Union group contains remains of cretaceous reptiles, while to the fossil botanist its plants appear to be unquestionably Tertiary. Hence also we are told that the skeleton of a Cretaceous Dinosaur has been found stuffed with leaves which Lesquereux regards as Eocene. At first these apparent anachronisms seem puzzling, and they interfere much with arbitrary classifications. Still they are perfectly natural, and to be expected where a true geological transition occurs. They afford, moreover, an opportunity of settling the question whether the introduction of living things is a slow and gradual evolution of new types by descent with modification, or whether, according to the law so ably illustrated by Barrande in the case of the Cephalopods and Trilobites, new forms are introduced abundantly and in perfection at once. The physical change was apparently of the most gradual character. Was it so with the organic change, That it was not is apparent from the fact that both Dr. Asa Gray and Mr. Cope, who try to press this transition into the service of evolution, are obliged in the last resort to admit that the new flora and fauna must have migrated into the region from some other place. Gray seems to think that the plants came from the north, Cope supposes the mammals came from the south; but whether they were landed from one of Sir William Thomson's meteors, or produced in some as yet unknown region of the earth, they cannot inform us. Neither seems to consider that if giant Sequoias and Dicotyledonous trees and large herbaceous mammalia arose in the Cretaceous or early Tertiary, and have continued substantially unimproved ever since, they must have existed somewhere for periods far greater than that which intervenes between the Cretaceous and the present time, in order to give them time to be evolved from inferior types; and that we thus only push back the difficulty of their origin, with the additional disadvantage of having to admit a most portentous and fatal imperfection in our geological record.

The actual facts are these. The flora of modern type comes into being in the Cretaceous of the West without any known ancestors, and it extends with so little change to our time that some of the Cretaceous species are probably only varietally distinct from those now living. On the other hand the previous Jurassic flora had died out apparently without successors. In like manner the Cretaceous Dinosaurs and Cephalopods disappear without progeny, though one knows no reason why they might not still live on the Pacific Coast. The Eocene mammals make their appearance in a like mysterious way. This is precisely what we should expect if groups of species are introduced at once by some creative process. It can be explained on the theory of evolution, only by taking for granted all that ought to be proved, and imagining series of causes and effects of which no trace remains in the record.

The problems for solution are, however, much more complicated than the derivationists seem to suppose. Let us illustrate this by the plants. The Cretaceous flora of North America is in its general type similar to that of the Western and Southern part of the continent at present. It is also so like that of the Miocene of Europe that they have been supposed to be identical. In Europe, however, the Cretaceous and Eocene floras, though with some American forms, have a different aspect, more akin to that of floras of the Southern Hemisphere. There have therefore been more fluctuations in Europe than in America, where an identical group of genera seems to have continued from the Cretaceons until now. Nay, there is reason to believe that some of the oldest of these species are not more than varietally distinct from their modern successors. Some that can be traced very far back are absolutely identical with modern forms. For example, I have seen specimens of a fern collected by Dr. Newberry from the Fort-Union group of the Western States, one of those groups disputed as of Cretaceous or Tertiary date, which is absolutely identical with a fern found by Mr. Dawson in the Lignite Tertiary of Manitoba, and also with specimens described by the Duke of Argyle from the Miocene plant beds of Mull. Further it is undoubtedly our common Canadian sensitive fern—*Onoclea sensibilis*. There is every reason to believe that this is merely one example out of many, of plants that were once spread over Europe and America and have come down to us unmodified throughout all the vicissitudes of the Tertiary ages. But while this is the case, some species have disappeared without known successors, and others have come in without known predecessors. Nay whole floras have come in without known origin. Since the Miocene age the great Arctic flora has spread itself all around the globe, the distinctive flora of North-Eastern America and that of Europe have made their appearance, and the great Miocene flora once almost universal in the Northern Hemisphere has as a whole been restricted to a narrow area in Western and warm temperate North America. Even if with Gray, in his address of two years ago before the American Association, we are to take for granted that the giant Pines (Sequoias) of California are modified descendants of those which flourished all over America and Europe in the Miocene, Eocene and Cretaceous, we have in these merely an exceptional case to set against the broad general facts. Even this exception fails of evolutionary significance, when we consider that the two species of Sequoia, which have been taken as special examples, are at best merely survivors of many or several species known in the Cretaceous and Tertiary. The process of selection here has been merely the dropping out of some out of several species of unknown origin, and the survival in a very limited area of two, which are even now probably verging on extinction: in other words, the two extant species of Sequoia may have continued unchanged except varietally from Mesozoic times, and other species existed then and since which have disappeared; but as to how any of them began to exist we know nothing, except that, for some mysterious reason, there were more numerous and far more widely distributed species in the early days of the group than now. This is precisely Barrande's conclusion as to the Palæozoic Trilobites and Cephalopods, and my own conclusion as to the Devonian and Carboniferous plants. It is rapid culmination and then not evolution but elimination by the struggle for existence.

The argument deduced from these successive floras reminds one of certain attempts which have been made in England to invalidate Barrande's law in his own special field. With a notice of one of these, which emanates from a successful collector of Primordial fossils, I shall close. He says, after referring to the different species of Paradoxides and allied genera in the Cambrian:—

"Other species show various gradations in the eyes and in the pygidium until we attain to *P. Davidis*, which has small eyes, a small pygidium, and the greatest number of thoracic segments. Indeed there are forms to represent almost every stage, and there can I think be no doubt that in the fauna of the Tremadoc group, which is separated from the earlier Cambrian by several thousand feet of deposits indicating a period of very shallow water in which large brachiopods and phyllopod crustaceans were the prevailing forms of life, we witness a return to very much the same conditions as existed in the earlier Cambrian periods, and with these conditions a fauna retaining a marked likeness to the earlier one, and in which the earlier types are almost reproduced, though of course greatly changed during their previous migrations. The *Niobe(?)* recently found in the Tremadoc rocks is truly a degraded *Paradoxides*, retaining the glabella and head spines, but with the rings of the thorax, excepting eight, consolidated together to form an enormous tail. Instead therefore of having here, as stated by M. Barrande, "a very important discord between Darwinism and facts," we find in these early faunas facts strongly favouring such a theory, and in support of evolution.

This is an exquisite piece of evolutionist reasoning, worthy of some of the greater masters of this peculiar logic. It is assumed that specific differences are "gradations" and the word "almost" covers the gaps between these. It is taken for granted that Paradoxides, which disappears with the Menevian age, has only gone upon its travels to parts unknown, and after the deposition of several thousand feet of beds, returns disguised as the Niobe of the Tremadoc,—and not only changed but "degraded",—a sorry result certainly of the struggle for existence in the interval, and holding out small prospect that the creature can be promoted in any subsequent age into a fish or even into a Decapod. If Barrande's reasoning can be met only in this way, he need not fear for the result. Seriously, one scarcely knows whether to be amused or grieved at the phases which the doctrine of derivation assumes in the writings of some modern naturalists. It is at least devoutly to be hoped, in order that science may not fall under the contempt of all thinking men, that the advocates of this hypothesis may become more careful in their treatment of facts, and more modest in their demands on our faith.

In the meantime the record of the rocks is decidedly against them in the particular point to which I have above adverted, namely, the abrupt appearance of new forms under several specific types and without apparent predecessors. They should direct their attention in this connection to the appearance of Foraminifera in the Laurentian, of Sponges, Brachiopods, Trilobites, Phyllopods, Crinoids, and Cephalopods in the older Palæozoic; of Land Snails, Millipedes, Insects, Fishes, Labyrinthodonts, Acrogens and Gymnosperms in the middle and later Palæozoic: of Belemnites, Dinosaurs, Ornithosaurs and other Reptiles, and of Marsupial Mammals and Dicotyledonons trees in the Mesozoic; of Placental Mammals and Man in the Tertiary and modern. When they shall have shewn the gradations by which these, out of the many cases which may be cited, have been introduced, and this without assuming an imperfection in the record incredible in itself and destructive of its value as a history of the earth, they may be in a position to rebuke us for our unbelief.

But it may be asked:—Have we no positive doctrine as to the introduction of species? In answer I would say that it is conceivable that the origin of species may be one of those ultimate facts beyond which science by its own legitimate methods cannot pass, and that all we can hope for is to know something of the modes of action of the creative force and of the modifications of which species when introduced are susceptible. In any case it is by searching for these latter truths that we may hope successfully to approach the great mystery of the the origin of life. It is with reference to these truths also that the discussion of modern theories of derivation has been chiefly valuable, and in so far as established they will remain as substantial results after these theories have been exploded. Among such truths I may mention the following: We have learned that in geological time species tend to arise in groups of like forms, perhaps in many parts of the world at once; so that genera and families culminate rapidly, then become stationary or slowly descend, and become restricted in number of species and in range. We have learned that in like manner each specific type has capacities for the production of varietal and race forms which are usually exercised to the utmost in the early stages of its existence, and then remain fixed or disappear and re-appear as circumstances may arise, and finally the races fall off one by one as it approaches extinction. Many of these races and varieties constitute conventional species as distinguished from natural species, and in so far as they are concerned, descent with modification occurs, though under very complex laws, and admitting of retrogression just as much as of advance. We have also learned that in the progress of the earth's history embryonic, generalised and composite types take precedence in time of more specialized types, and thus that higher forms of low types, precede higher types and are often replaced by them. We are further, as the relation of varieties and species is investigated and their extension in time traced, becoming more and more convinced of the marvellous permanence of specific types, and of their powers of almost indefinite propagation in time. Lastly, vast stores of facts are being accumulated as to the migration of species from one area to another and as to the connection of the great secular elevations and subsidences of continents with their introduction and extinction. All these are substantial gains to science, and the time is at hand when they will lead to more stable theories of the earth than those now current. If I am not greatly mistaken, these considerations or some of them will be found to cover the case recently so much insisted on of the Tertiary predecessors of the modern Horse; a case which includes a great number of complicated and curious successions and relations, which we may hope to consider at a future time, when the American facts relating to them have been more fully elaborated.

I have however digressed from my special subject, and in returning to it, and in closing this address, would express my thankfulness that here in America we have a field for work on so broad a scale that there is little temptation to abandon the ever fresh and exciting exploration of new regions and the discovery of new facts, and the working out of legitimate conclusions, for that process of evolving worlds out of our own consciousness which seems to be the resource of those who have access only to the often ransacked treasuries of nature in smaller and older countries. Placed on a continent which in its geological development is the grandest and noblest of all, and which may be made a type for all the rest, let us push forward the conquests of legitimate science, and bear in mind that our present aim should be above all things the diminution of that imperfection of the geological record of which so much complaint is made.

The Report of the Chairman of Council was read by Mr. G. L. Marler, as follows:

REPORT OF THE CHAIRMAN OF COUNCIL.

At the close of another Session, your Council beg to submit the following Report:—

During the past year eighteen new ordinary members have been elected, a number though small, slightly in advance of last year's accessions. The new collector not having furnished the necessary data, it is impossible to state with accuracy what losses have been sustained by death, removal, or other causes. A circular, inviting the co-operation of ladies in the work of the Society, has been issued and distributed at meetings of the Ladies' Educational Association, and on other suitable occasions. Seven ladies have become associate members, and the Council suggest to their successors to try and interest more ladies in the objects which the Society was formed to promote.

The number of visitors to the museum, during the past Session, is about one thousand.

After continual remonstrances with the corporation of Montreal, and petitions to that body, the cab-stand in front of the premises, which was so great a nuisance to the Society and so detrimental to its interests, has been in part removed.

Through the kindness and liberality of friends, and especially in consequence of the active exertions of Mr. Selwyn (to whom the Society's thanks are specially due in this matter), your Council are happy to be enabled to report that Messrs. Dawson Bros.' account, amounting at the last annual meeting to $653.92, has been entirely liquidated. The following is a list of the donors, to whom the cordial thanks of the Council are hereby tendered:

Sir W. E. Logan, LL.D., F.R.S.	$50
James Ferrier, Jun	50
J. H. Joseph	50
W. F. Kay	50
Peter Redpath	50
C. J. Brydges	50
His Excellency the Governor-General	20
Principal Dawson	20
Sir Hugh Allan	20
Donald A. Smith	25
H. Archibald	20
E. Murphy	20
R. J. Reekie	20
G. B. Burland	20
Messrs. Walker and Miles	20
Sir Francis Hincks	10
Hon. Judge Torrance	10
John H. Molson	10
John Molson	10
D. J. Greenshields	10
John Kerry	10
Messrs. Morland, Watson & Co.	10
G. L. Mailer	10
N. Mercer	10
John Lovell	10
Kenneth Campbell	10
Messrs. Savage, Lyman & Co.	10
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D. Lorn MacDougall	10
H. Benjamin	10
Rev. Dr. De Sola	10
B. Gibb	10
W. Notman	10
D. R. McCord	10

D. W. & Co.	10
Messrs. Prowse, Bros.	5
Jas. Sutherland	5
Thomas Irving	5
F. W. Henshaw	5
Rev. Gavin Lang	5
James Bissett	5
W. D. McLaren	5
E. J. Major	5
H. Shackell	5
S. Waddell	5
Scott Barlow	5
John Date	5
D. Sinclair	5
Charles H. Waters	5
H. Lyman	5
Henry Morgan & Co	5
A Friend	5
A Friend	5
Dr. Reddy	3
W. Grant	2
F. C. & Co	2
H. J. Shaw	2
M. Cassidy	2
F. H. Harrison	2
A. Freeman	1
W. Marler	1
	$800

A case to hold alcoholic preparations has been made, the cost of which ($45) has been defrayed by the liberality of the following gentlemen :

M. H. Brissette	$35	
G. Barnston	5	
J. Ferrier, jun	5	—$45

On the occasion of the Dominion Cabinet meeting at Montreal in June last, the Hon. the Minister of Marine and the other Ministers of the Privy Council, were invited to visit the museum, which, however, they were unable to do.

A memorial has been sent to the present Minister of Marine and Fisheries, asking for increased facilities for dredging operations in the Gulf, but the answer received has been unfavorable, and your Council regret that for the time at least these investigations will have to be discontinued.

A petition to the Legislature of the Province of Quebec for a special donation of $1,000 to liquidate the debt due on the Society's buildings has proved unsuccessful, although the usual Government grant of $750 has been duly received.

The basement has been thoroughly cleaned, and attempts have been made to remedy the defective ventilation of the ground flat. Some dissatisfaction having been evinced by members of the Council at the amounts of bills for repairs, &c., Messrs. J. H. Joseph and E. E. Shelton were appointed a committee to supervise and examine into necessary expenses of this kind, and the thanks of the Society are due to them for the trouble they have taken in the matter.

In consequence of Mr. Ferrier's time being so much preoccupied, Mr. E. E. Shelton has kindly acted as Assistant-Treasurer.

The Ladies' Educational Association have, as on two previous Sessions, used the rooms for their lectures, but do not intend to continue doing so: they complain of insufficient heating and defective ventilation.

The Somerville Course of Lectures has been duly delivered to good audiences; the titles of the lectures, with the names of their authors, will be found in the proceedings of the Society.

No conversazione or field day have been held during the past Session, but your Council is of opinion that it is desirable to hold one or two field meetings before the first of July.

The following report was then read by Mr. J. F. Whiteaves:

REPORT OF THE SCIENTIFIC CURATOR AND RECORDING SECRETARY.

The work done during the past session is very similar in character to that of the two previous years. Shortly after the last annual meeting, as soon as the necessary preparations were made, nine weeks were spent in active dredging operations in the Gulf of St. Lawrence. As the Schooner was employed exclusively for this particular service during that time, the number of specimens collected was far greater than on any previous occasion.

These, together with undetermined specimens remaining over from collections made in former years, have been as carefully studied as the time at my disposal would permit.

The Foraminifera have not been examined much in detail, as it has been found that on the whole they do not yield a return in the shape of new discoveries, at all commensurate with the time spent upon them. Only one form new to the St. Lawrence has been noticed so far.

Much more attention has been devoted to the Sponges. Of the 40 or 50 Canadian species represented in Montreal cabinets, the generic and specific names of about 15 have been ascertained with tolerable certainty. Although this number may seem small, it may be mentioned that many of those that are undetermined are probably new to Science, and in Principal Dawson's Handbook of Geology, published in 1869, only three are enumerated, of which one is fossil, and of another the specific name is not given.

The Hydrozoa have been submitted to further microscopical examination. Eleven species have been added to our fauna, of which two are new to America. Some of the deep sea species are different from any of those described by English writers.

No special novelties occurred among the Alcyonaria and Zoantharia collected last summer, but the whole series has been carefully studied and all the species made out and labelled. The Echinodermata have given better results, eight species new to the St. Lawrence, of which three are new to America, have been collected and determined. Three of these are brittle stars and three sea cucumbers.

A further portion of the Marine Polyzoa has been carefully studied. The latest catalogue of these beautiful corallines, published as a report to the department of Marine and Fisheries last year, gave 39 species. Fifteen additional forms have been recognized, all of which are new to the Gulf of St. Lawrence. Most of them are very rare and striking kinds, and several of them are new to the American side of the Atlantic. Not one half of the material collected, however, has been examined, even in a somewhat cursory way.

The whole of the Tunicates of the St. Lawrence in the Society's collection, with the exception of a purple Botryllus, whose specific relations are still obscure, have been determined and labelled. There are some 17 species, and the Society is indebted to Prof. Verrill, who has made the study of these molluscoids a specialty, for the identification of several critical species, originally described by him.

The Shells proper, collected last summer, have all been examined and determined. In 1869 the catalogue of shells from the Northern part of the Gulf, which was complete up to date, gave 115 species. Including the discoveries of Mr. Willis on the Nova Scotian coast and additional species dredged by Principal Dawson, as well as novelties obtained in the government expeditions of 1871, 1872, and 1873, 214 species are now known from that region.

Of these 91 are bivalves
" " 107 " gasteropods.
" " 3 " pteropods.
" " 3 " cephalopods.

Through the kindness of Dr. W. C. McIntosh, of Perth, an eminent authority on this group, the marine worms of the St. Lawrence are in a fair way of being worked up. The whole of the specimens dredged during the last three summers, filling about 200 bottles, have been forwarded to him.

In the April No. of the Annals of Natural History, Dr. McIntosh has published the result of his studies on those Canadian specimens which belong to the first six families in the classification proposed by Malmgren. The general results are that 19 species have been determined, of which six are new to science. These latter have been described and figured in the Journal previously mentioned.

With the assistance of Mr. S. I. Smith, of Yale College, who has identified most of the Amphipods and the more critical among the Decapods, most of the crustaceans recently collected have been determined. 56 species have been added to our local lists, several of which are Norwegian forms, not hitherto met with on the American coast. One of these is a curious new generic type collected in the deep sea mud, and described in a recent number of the American Journal of Science and Arts. The few fishes collected at great depths, some of them of great interest, and including about 10 species, have been studied and labelled.

Extentive exchanges have been made with Professors Verrill and S. I. Smith, and in this way about 120 species collected in dredgings under the auspices of the U. S. Fish Commission, have been obtained. All of these are carefully named. The whole series has been put into a fresh set of bottles, and re-labelled.

The new case for alcoholic preparations mentioned by the Chairman of Council now contains 250 species of N. American marine invertebrates, each in a separate bottle labelled with the proper locality and name of the object it contains. In addition to this, there are about 150 bottles (or jars) full of various marine animals dredged in the Gulf, which have yet to be studied. Before leaving this topic, it may be as well to mention that an article giving a condensed account of the zoological results of last summers investigations has been published in Silliman's Journal for March last, and that a more detailed account of the observations made, has been submitted as a report to the Minister of Marine and Fisheries for the Dominion Government. This is now in type and will shortly be issued. The subject has been also brought before the Society at one of its monthly meetings.

Some progress has been made in the re-arrangement of the Society's very interesting and valuable collection of fishes amphibia and reptiles, but the work in this direction has been stopped, on account of the want of proper bottles, and of alcohol. Many rare exotic snakes, lizards, fishes &c., presented to the Society some years ago by Dr. Gunther, have never been accessible to students, because we had no proper means of exhibiting them It is eminently desirable to have a much better series of the smaller fishes, newts, frogs &c. of Canada, for reference, than we can now boast. If a small expense were incurred to obtain alcohol, and suitable bottles, the specimens could soon be obtained. As it is, our small collection has been greatly augmented by a donation of a series of the snakes of Western Canada, presented by Mr. Passmore.

In the department of Canadian birds, the additions have been about equal to the average of former years. Some rare United States species have been presented by Mr. LeChevallier. Among these are the painted quail of Texas, and the Brown and Frigate Pelicans of Florida.

Major Bulger has most liberally presented us with a collection of 60 specimens, of the Birds of the Neilgherry Hills and from the Deccan. These have been duly labelled, and the attention of the Society has been called to them in a paper read at one of our monthly meetings.

By exchange with Mr. LeChevallier the Society has acquired the eggs of about 80 species of N. American birds, some of them of considerable rarity. They are all fine specimens, mostly blown in the most approved fashion, and have all been marked with names and localities.

The most important additions to the mammalia are an unusually fine specimen of the Canadian or American wolf, obtained through the kind instrumentality of Mr. Vennor and other gentlemen, mostly connected with the Geolgical Survey; a good specimen of the Badger, presented by Prof. Bell, and a Skunk, given by Mr. S. J. Lyman.

A small series of U. S. Rodents has recently been received from the Smithsonian Institute at Washington, but they are mostly in a bad state of preservation, and none of them have been mounted as yet.

The Society's permission having been duly obtained, at Mr. Selwyn's request some time has been spent in the examination of the Cretaceous fossils collected by Mr. Richardson at Vancouver and the adjacent islands, in 1873. The series, though small, is exceedingly interesting. Occupying a position apparently at or near the base of the Upper Cretaceous, perhaps synchronic with the Upper Greensand or Gault, these fossils, with one or two exceptions, belong to genera not yet recognized from corresponding formations in Europe. A supplementary report on these is in progress.

The correspondence involved in endeavoring to work out the material collected in the Gulf, has been considerable and the microscopic work heavy. The proceedings of the Society have been duly published in the Local Press, and it is hoped that the other Secretarial duties have been efficiently performed.

The Treasurer being unable to attend the meeting, the following statement of the financial position of the Society for the past session was submitted on his behalf, by the Chairman of Council:—

REPORT OF THE TREASURER.

Dr. THE NATURAL HISTORY SOCIETY OF MONTREAL in account with JAMES FERRIER, Jun., Treasurer. **Cr.**

1872—'73.	
To Cash paid interest	$ 70.00
" " Mr. Whiteaves	400.00
" " Mr. Passmore	200.00
" " Messrs. Pell and Foote	34.20
" " For Coal and Wood	250.00
" " Gas	55.30
" " Water	38.50
" " City Taxes	56.00
" " Insurance	44.00
" " Repairs and Petty Expenses	201.40
" " Books, Printing and Advertising	913.91
Balance in Treasurer's hands	255.94
	$2519.25

1873, May 1.	
By Balance in Treasurer's hands	$ 0.60
" Government Grant	750.00
" General Contributions	738.00
" Subscriptions to "Naturalist"	99 00
" Members' Yearly Subscriptions	632.00
" Museum Entrance Fees	76.15
" Rent of Rooms	221.00
" Freight Collected on Books	2.50
	$2519.25

Errors and Omissions excepted.

[Signed] JAMES FERRIER, Jr.

Montreal, May 18th, 1874.

It was moved by Dr. J. Baker Edwards, seconded by W. Muir and resolved:

"That the foregoing reports be adopted, printed, and distributed to the members."

On motion of Rev. Dr. De Sola the thanks of the meeting were unanimously voted to Principal Dawson for the preparation of the annual address.

Rev. Dr. De Sola moved, seconded by E. E. Shelton, that the bye-law relating to the balloting for officers be suspended and that A. R. C. Selwyn, F.R.S. be elected President. The motion was carried by acclamation.

Dr. J. B. Edwards moved, seconded by Rev. A. De Sola, that the Cor. Secretary and the Scientific Curator and Rec. Secretary be re-elected without the form of balloting. The motion was duly adopted.

Dr. B. J. Harrington and Prof. P. J. Darey having been nominated scrutineers, the following officers were elected by ballot in the usual way.

Vice-Presidents—Sir W. E. Logan, L.L.D., F.R.S.; Rev A. De Sola L.L.D.; G. Barnston; E. Billings F.G.S.; Principal Dawson L.L.D., F.R.S.; His Lordship the Metropolitan; C. Robb.

Treasurer—E. E. Shelton.

Council—Dr. B. J. Harrington, D. A. P. Watt, G. L. Marler, Prof. R. Bell, J. H. Joseph, Dr. J. B. Edwards, Rev. Canon Baldwin, D. R. McCord and Jas. Ferrier Jr.

It was moved by J. H. Joseph, seconded by Dr. J. B. Edwards and resolved:

"That the Library and Membership Committee do consist of the following gentlemen: N. Mercer, W. Muir, Dr. John Bell, G. R. Grant and J. B. Goode."

Mr. J. H. Joseph moved, seconded by C. Robb:

"That the special thanks of the Society be voted to Mr. J. Ferrier, jun. for his long continued and valuable services as Treasurer." The motion was adopted unanimously.

On motion of Mr. E. E. Shelton, seconded by W. Muir, it was resolved:

"That in future the number of Vice-Presidents be limited to seven."

ON SOME NEW GENERA AND SPECIES OF PALÆOZOIC MOLLUSCA.

By E. Billings.

Genus Ilionia (n. gen.)

The above generic name is proposed for such forms as *Tellina prisca* (Hisinger), *Anatina sinuata* (Hall), and the species herein described. All the specimens I have seen are internal casts, and the characters of the hinge-line, therefore, cannot be given. The form is irregularly ovate, compressed or sub-lenticular; one extremity larger than the other; beaks turned towards the larger end, which is therefore supposed to be anterior. In all the species a concave depression commences on the umbones and extends downwards to the posterior ventral margin. A large sub-ovate muscular impression in the upper half of the posterior extremity.

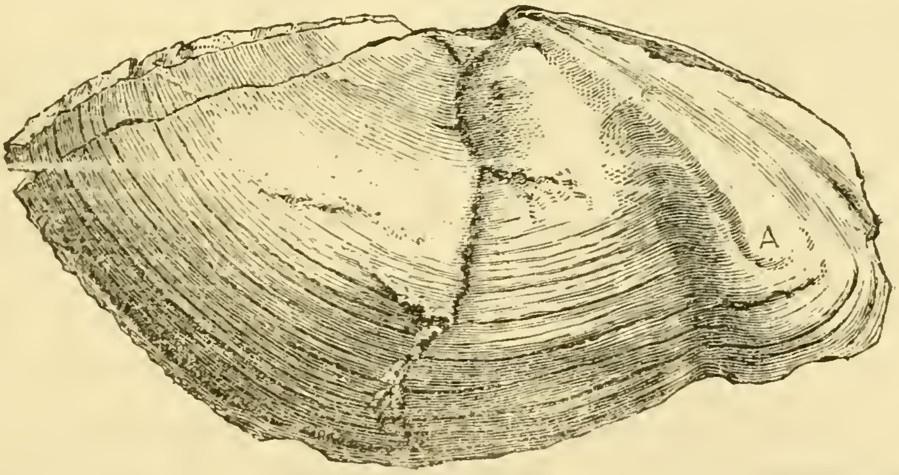

Fig. 1.—Left side of a cast of the interior of *I. Canadensis*.

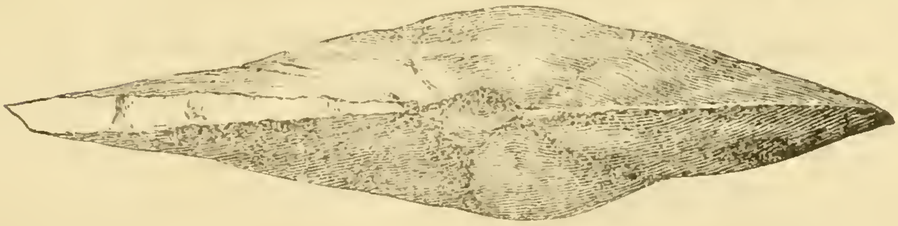

Fig. 2.—Dorsal view of the same.

1.—*I. Canadensis* (n. sp.) Transversely irregularly ovate; compressed, sub-lenticular; length about twice the greatest height; umbones situated a little behind the mid-length; ventral margin with a concave notch at about the posterior fourth of the whole length. In front of this notch the margin is uniformly convex, gradually sloping upwards nearly (if not quite) to the hinge-line. The dorsal margin is not perfect in the specimen figured, but judging from the direction of the striæ on the surface of the cast, it is nearly straight, or at the most, only gently convex in front of the beaks, and nearly parallel with the length of the shell, sloping slightly downwards. Behind the beaks it is gently convex, nearly straight, and slopes downwards to the narrowly rounded posterior angle, the latter situated at about one-third the height of the shell. The margin behind the beaks is compressed. Close under the beaks, in front, there appears to have been a short escutcheon. From the umbones backwards for about six lines, a linear groove runs along close to the dorsal edge on each side. This may be related to the ligament.

The most projecting point of the anterior extremity appears to be situated considerably above the mid-height of the shell, near the hinge line. The posterior angle is below the mid-height.

Surface concentrically striated.

Length 3 inches; greatest height, a little in front of the mid-length 18 lines; greatest depth of both valves, just below the umbones 8 lines.

The specimen was collected by Sir W. E. Logan in the Upper Silurian rocks at Port Daniel on the Bay of Chaleurs.

Genus PTERONITELLA, (n. gen.)

Among the fossils collected at Arisaig, Nova Scotia, in the Upper Silurian, there are many casts of the interior, of several species congeneric with *Avicula retroflexa* (Hisinger). These show that in front of the beaks, there are several small cardinal teeth, and that close beneath the hinge line there are several more or less elongated posterior teeth. This arrangement is quite different from that of both *Avicula* and *Pterinea*, to which these shells are usually referred. There is a strong anterior muscular impression and the whole structure of the hinge resembles closely that of *Cyrtodonta*.

Prof. McCoy has noticed the teeth, in his description of *P. retroflexa* (Pal. Foss., p. 262) but does not seem to think their structure of generic importance. The above generic name is proposed, to include *P. retroflexa* and some others, soon to be described.

GEOLOGICAL SOCIETY OF LONDON.

March 25th, 1874.—John Evans, Esq., F.R.S., President, in the chair. The following communication was read:

1. "On the Upper Coal-Formation of Eastern Nova Scotia and Prince Edward Island, in its relation to the Permian." By Principal Dawson, LL.D., F.R.S., F.G.S.

The author described the Carboniferous district of Pictou county as showing the whole thickness of the Carboniferous system arranged in three synclinals, the easternmost consisting of the Lower series up to the Middle Coal formation, and including all the known workable Coal-measures in the district, the second towards the west of the middle and the lower part of the Upper Coal-formation, and the third showing in its centre the newest beds of the latter. On the north the bounding anticlinal of the first depression brings up the New-Glasgow Conglomerate, which contains boulders 3 feet in diameter, often belonging to Lower Carboniferous rocks, and represents the upper part of the Millstone-grit or the lower part of the Middle Coal-formation. The author regards this as representing an immense bar or beach, which protected the swamps in which the Pictou main coal was formed.

The succession of the deposits above the Conglomerate was described in some detail as seen in natural sections. The Upper Coal-formation, as shown in the section west of Caribou Harbour, consists of, 1. Red and grey shales, and grey, red and brown sandstones; and 2. Shales, generally of a deep red colour, alternating with grey, red and brown sandstones, the red beds becoming more prevalent in the upper part of the section. In Prince Edward Island beds apparently corresponding to these are found, and also gradually become more red in ascending. These are overlain, apparently conformably, by the Trias.

The author gave a tabular list of 47 species of plants found in the Upper Coal-formation of Nova Scotia and Prince Edward Island, and stated that all but about ten of these occur also in the Middle Coal-formation. The number of species decreases rapidly towards the upper part of the formation; and this is especially the case in Prince Edward Island, some of the beds in which are considered by the author to be newer than any of those in Nova Scotia. The plants contained in the upper deposits were compared with those of the European Permian, and a correlation was shown to exist between them, so that it becomes a question whether this series was not synchronous with the lower part of the Permian of Europe, although in this district there is no stratigraphical break to establish a boundary between Carboniferous and Permian. The author therefore proposes to name these beds Permo-Carboniferous, and regards them as to some extent bridging over the gap which in Eastern America separates the Carboniferous from the Trias.

DANA'S MANUAL OF GEOLOGY.—The second edition of Prof. J. D. Dana's excellent Manual of Geology has just been published. The first edition made its appearance in 1862. During the twelve years that have elapsed, numerous and important discoveries in Geology and Palæontology have been made, especially on this Continent. The results of these are embodied in this new edition, which thus gives a full exposition of the science as it stands at the present day.

The Manual is an octavo volume of 828 pages, illustrated by 1122 excellent wood engravings of fossils, sections and geological phenomena, besides a physiographic chart of the world. It is divided into four parts, 1. Physiographic Geology; 2. Lithological Geology; 3. Historical Geology; and 4. Dynamical Geology. Each of these four subjects is thoroughly explained and illustrated. Of these the third part, the most important, occupies 456 pages, and is copiously illustrated by groups of the characteristic fossils of all the formations. Among these will be found a large number of the principal organic remains of our Canadian rocks. Such a book as this will be found exceedingly useful to those who do not intend to follow Geology as a profession, but still are desirous to acquire by private study such a general idea of the principles of the science as every well-informed man should be possessed of. It contains in a condensed form the substance of a whole geological library.

Its value to the college student is too widely known to need a notice here. One of the most interesting illustrations is the frontispiece, representing the fossil man of the early stone age, just as he lay during his long sleep for thousands of years in the Cave of Mentone.

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Published July 11th, 1874.

THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

NOTES ON DAWSONITE, A NEW CARBONATE.

By B. J. Harrington, B.A., Ph.D.

Chemist and Mineralogist to the Geological Survey of Canada.

In the present paper I wish to describe a new mineral, which on account of its peculiar composition seems to be of more than ordinary interest.

In 1862 Messrs. J. H. and G. Gladstone described, under the name of Hovite, a mineral which they suggested might be regarded as a double carbonate of *alumina* and lime.[*] On the ground, however, of a carbonate in which alumina or sesquioxide of iron enters being unknown to chemistry, and from the fact that the so-called Hovite occurs mixed with Collyrite, a hydrous silicate of alumina, Dana regards the alumina as belonging wholly to the admixed material, and considers the lime to be present in the state of *bicarbonate*. With regard to it he says: "Although the bicarbonate referred to is known only in solution, the most likely condition for finding it in the mineral kingdom is in one of the hydrous silicates of alumina, like collyrite, in which there is present much water, loosely held; the mineral therefore is most probably a carbonate of the formula above given $(\frac{1}{2}CaO + \frac{1}{2}HO)\ CO_2 + aq$; especially since a carbonate in which Al_2O_3 or Fe_2O_3 enters is, as the authors (the Messrs. Gladstone) admit, yet unknown to chemistry."

Now although the formation in the laboratory of a carbonate of alumina has been denied by some chemists, we find Fresenius stating that * "carbonates of the alkalies throw down from solutions of alumina basic carbonate of alumina." Watts in his Dictionary of Chemistry writes carbonate of alumina with a query after it, and Valentin, of the Royal College of Chemistry, says that carbonate of soda, or carbonate of ammonia, precipitates from solutions of alumina "basic carbonate of uncertain composition."† Langlois, Wallace, and Muspratt have all regarded the precipitate formed by alkaline carbonates as consisting of hydrated carbonate of alumina, but each of them has assigned to it a different formula. H. Rose, on the other hand, states that the precipitate formed by carbonate of ammonia is a compound of trihydrate of alumina with carbonate of ammonia.‡ We cannot then, I think, confidently assert that a carbonate into which alumina enters is unknown to chemistry, but simply that it is one of those points upon which "doctors differ." I refer to it here, because it has a certain bearing upon the mineral which is the subject of this paper.

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[*] Phil. Mag., IV. xxiii. 462, 1862.

[†] Mineralogy, 5th ed. p. 709.

This mineral is a carbonate, the principal bases in which are alumina, lime, and soda; the carbonic acid being considerably in excess of the amount required to form neutral carbonates with the bases other than alumina. It occurs in the joints of a trachytic dyke near the western end of McGill College, and having been first collected by Principal Dawson, has, in honour of him, been called Dawsonite.

The rock constituting the dyke was examined by Dr. Hunt some years ago; but no special analysis of the Dawsonite was made, as sufficient material could not then be obtained. As the composition of the dyke is of interest in connection with that of the material filling its joints, I give Dr. Hunt's description and analyses. He says §: "The rock is divided by joints into irregular fragments, whose surfaces are often coated with thin bladed crystals of an aluminous mineral, apparently zeolitic. Small brilliant crystals of cubic iron pyrites, often highly modified, are disseminated through the mass. The rock has the hardness of feldspar, and a specific gravity of from 2.617 to

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* Man. Qual. Chem. Anal. ed. by S. W. Johnson, M.A., p. 111. New York, 1869.

† Text Book of Practical Chemistry. London, 1871. p. 175.

‡ Watt's Dict. of Chem. vol. I, p. 779.

§ Geology of Canada, 1863, pp. 659, 660.

2.632. It has a feebly shining lustre, and is slightly translucent on the edges, with a compact or finely granular texture, and an uneven sub-conchoidal fracture. Before the blow-pipe it fuses, with intumescence, into a white enamel. The rock in powder is attacked even by acetic acid, which removes 0.8 per cent. of carbonate of lime, besides 1.5 per cent. of alumina and oxyd of iron; the latter apparently derived from a carbonate. Nitric acid dissolves a little more lime, oxydises the pyrites, and takes up, besides alumina and alkalies, a considerable portion of manganese. This apparently exists in the form of sulphuret, since, while it is soluble in dilute nitric acid, the white portions of the rock afford no trace of manganese before the blow-pipe; although minute dark-colored grains, associated with the pyrites, were found to give an intense manganese reaction. From the residue after the action of the nitric acid, a solution of carbonate of soda removed a portion of silica; and the remainder, dried at 300°F. was free from iron and from manganese."

No. I. is Dr. Hunt's analysis of the portion insoluble in nitric acid; No. II. that of the matters dissolved by nitric acid from 100 parts of the rock:—

	I.		II.
Silica	63.25	....	1.43
Alumina	22.12	....	2.43
Peroxyd of iron	....	....	2.40
Red oxyd of manganese	....	....	1.31
Lime	0.56	....	0.60
Potash	5.92	....	0.40
Soda	6.29	....	0.98
Volatile	0.93	....	....
	99.07		

The bladed, aluminous mineral alluded to by Dr. Hunt is the Dawsonite of this paper, and will now be described.

Physical Characters.—Hardness 3. Specific gravity 2.40. Lustre vitreous. Colour white. Transparent—translucent.

As mentioned above, it is bladed, but the blades show a somewhat fibrous structure, which is best seen when fragments are examined under the microscope. With polarized light it exhibits beautiful bands of brilliant colours. As regards its crystalline form I am uncertain, though it is probably monoclinic, with the inclination of the principal axis about 75°.

Chemical and Blowpipe Characters.—Before the blowpipe colours the flame intensely yellow, becomes opaque, and often exfoliates or swells up into cauliflower-like forms. After ignition in the forceps, or in the closed tube, gives a strong alkaline reaction. Fragments which have not been ignited, when placed upon a piece of moistened turmeric paper, shew no alkaline reaction; but if the finely pulverised mineral is treated with water, the water is rendered slightly alkaline. In the closed tube gives off water and carbonic acid. With nitrate of cobalt gives a fine blue colour (alumina.) With hydrochloric or nitric acid dissolves in the cold completely, with evolution of carbonic acid; and this even when the mineral is in fragments and the acid exceedingly dilute. Addition of ammonia to the solution gives a copious precipitate of alumina. Acetic acid decomposes it, but does not appear to dissolve it completely; the solution, however, gives an abundant precipitate of alumina with ammonia.

Through the kindness of Dr. Dawson I have been enabled to obtain sufficient material for two analyses. The first was made some months ago, but so strange did the results appear, that I was unwilling to publish them before making a second analysis, in order to ascertain whether the mineral was at all constant in composition.

The first analysis gave me the following results:

I.	
Carbonic acid	29.88
Alumina*	32.84
Lime	5.95
Magnesia	traces.
Soda	20.20
Potash	0.38
Water	11.91
Silica	0.40
	101.56

The carbonic acid was determined with an ordinary single flask apparatus, and the water with a small chloride of calcium tube. Together they equal 41.79 per cent. Direct ignition of a separate portion of the mineral in a covered crucible gave a loss of 41.16 per cent.

For the second analysis, the material was obtained from at least twenty different specimens, and considering that the amount employed was small, the results are sufficiently close to those of

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* With traces of peroxide of iron.

No. I. to warrant the conclusion that the mineral is constant in composition. They are as follows:

II.

Carbonic acid	30.72
Alumina with traces of Fe_2O_3	32.68
Lime	5.65
Magnesia	0.45
Soda	20.17
Water	[10.32]
	100.00

In this analysis the total alkaline chlorides are calculated as soda, the amount of potash not having been determined.

In No. 1 the excess of carbonic acid above that required to form neutral carbonates with the bases other than alumina is 10.69; while in II. it is 11.46. This excess must either be in combination with the alumina, or else must go towards forming bicarbonates with a portion of the protoxide bases. If the alumina is not present as carbonate, we might then suppose it to exist as hydrate. There is, however, not sufficient water to form trihydrate, the compound known in nature as Gibbsite, and too much to form the monohydrate or diaspore. Native trihydrate, moreover, is only soluble in acids with difficulty, and diaspore is insoluble, unless after ignition.

The amount of water is about that which would be required to form dihydrate,—a hydrate which, as prepared in the laboratory, is soluble in acetic acid, though insoluble in the stronger acids. But hydrochloric, or nitric acid, readily dissolves all the alumina in the Dawsonite.

The crystalline character of the mineral, and the uniformity of its optical and chemical characters, forbid its being regarded as a mechanical mixture; and, for the present, we can only say that it may be a hydrous carbonate of alumina, lime and soda, or perhaps a compound consisting of a hydrate of alumina combined with carbonates of lime and soda.*

If we adopt the former view, and consider that alumina may exist in combination with carbonic acid, we need no longer consider Hovite as a bicarbonate of lime, but may adopt the suggestion of the Messrs. Gladstone, that it is a double carbonate of alumina and lime.

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* There is nearly enough carbonic acid to form neutral carbonate with the lime, and bicarbonate with the soda.

THE FLUCTUATIONS OF THE AMERICAN LAKES AND THE DEVELOPMENT OF SUN-SPOTS.

By G. M. Dawson, Assoc. R. S. M.

In the course of an investigation, undertaken in my capacity as Geologist to the B. N. A. Boundary Commission, as to late changes of level in the Lake of the Woods, bearing on the accuracy of certain former surveys, I found it desirable to tabulate the better-known fluctuations of the great lakes for a series of years as a term of comparison. The observations of secular change in Lake Erie are the most complete, and these, when plotted out to scale, showed a series of well-marked undulations which suggested the possibility of a connection with the eleven-yearly period of sun-spot maxima. A comparison with Mr. Carrington's diagram of the latter confirmed this idea, and as I do not remember to have seen these phenomena connected previously, I have been induced to draw out the reduction of both curves here presented, and the table of the height of water in the lakes.

The changes of level effecting the great lakes are classed as follows by Colonel Whittlesey, who has given much attention to the subject:—

1. General rise and fall, extending through a period of many years, which may be called the "Secular Variation."

2. Annual rise and fall within certain limits, the period of which is completed in about twelve months.

3. A sudden, frequent, but irregular movement varying from a few inches to several feet. This is of two kinds, one due to obvious causes, such as winds and storms; another, described as a slow pendulum-like oscillation, has been somewhat fully discussed by Whittlesey in a paper read before the American Association at its last meeting, and is due probably to barometric changes in the superincumbent atmosphere.

The first class is the only one directly included in the present inquiry.

I.—*Table of Great Lakes.*—In Mr. Lockyer's new work on Solar Physics, chap. xxvi., entitled "The Meteorology of the Future," exhibits the parallelism of periods of solar energy, as denoted by the outburst of sun-spots, with the maximum periods of rainfall and cyclones, and for the southern hemisphere, by a discussion of his own and Mr. Meldrum's results. In the table (p. 313) I have arranged the more accurate numerical observations of the height of the lakes from registers kept for the last few years, in a method similar to that there adopted.

Prof. Kingston's observations of Lake Ontario were taken at Toronto, and measured upward from an arbitrary mark. They extend from the year 1854 to 1869, and include the minimum periods of 1856 and 1867, and the maximum of 1860. Taking the mean annual level for each minimum and maximum epochal year, and one year on each side of it, as is done by Mr. Meldrum, and deducing a mean from each of three tri-yearly periods, the agreement is close between the solar periods and those of fluctuation in the lakes.

The remaining observations are those of the U.S. Lake Survey, and include only one period each of maximum and minimum in solar spots. The measurements of the U.S. Survey are reckoned *downwards* from a mark representing the high water of 1838 in each of the lakes, but in the table here given they have been reduced so as to read upwards from an arbitrary line chosen 4 feet below that datum. They are thus rendered more intelligible and made to agree in sense with Prof. Kingston's measurements.

The result is the same in each of the lakes, only differing in amount by a few inches. A mean deduced from the U.S. Lake Survey observations in Lakes Superior, Michigan, Erie, and Ontario, gives a difference between the years surrounding the maximum of 1860 and the minimum of 1867 of 14.64 inches in favour of the former.

2. *Diagram of Curves.*—The curve representing the fluctuation of Lake Erie from 1788 to 1857 inclusive is constructed on a careful discussion of the evidence collected by Col. Whittlesey and given by him most fully in the "Smithsonian Contributions to Knowledge" for 1860.

From 1788 to 1814 there are no accurate measurements to any well-recognised datum line, and I therefore give below the measurements and approximations on which the general curve for these years has been constructed. The description of the fluctuation of the lake will be seen in many cases to apply with verbal accuracy to the sun-spot curve.

"1788—1790. By tradition derived from the early settlers, very high; according to some as high as 1838, but this is doubtful.

"1796. By the first emigrants and surveyors reported as very low—5 feet below 1838.

"1797. Rising rapidly.

"1798. Water continues to rise, but 3 feet below June 1838.

"1800. Very high; old roads flooded.

"1801. Still high.

"1802. Very low; reported by old settlers as lower than 1797.

"1806. Very low; reported by old settlers as lower than 1801—2, and declining regularly to 1809—10 when it reached a level by many considered as low as that of 1819.

"1811. Rise of 6 inches in the spring over 1810, by measurement, and a fall of 2 inches.

"1812. Rise of 14 inches in spring over 1810, by measurement, and a fall of 3 inches.

"1813. Rise of 2 feet 2 inches in spring over 1810 by measurement.

"1814. Rise of 2 feet 6 inches in spring above general level of 1813."

From 1815 to 1833, both inclusive, occasional measurement to fixed data exist; the supplementary notes are here given.

"1815. Rise of 3 feet above average level of 1814. (This statement is not confirmed by an actual measurement made in August, and is probably exaggerated).

"1816. Water still high, but falling, and continued to fall till 1819.

"1819. Lowest well-ascertained level of the waters in Lake Erie.

"1820. Stated to be in August as low as 1819.

"1821. Rising.

"1822. Rising: in the spring 4 feet below June 1838.

"1823. Rising; in the spring 3 feet 3 inches below 1838.

"1824. Rising gradually.

"1825. Rising; lowest level 3 feet below June 1838.

"1826. Rising; lowest level 2 feet 10 inches below June 1838.

"1827. About the general level of 1815.

"1829. Water still rising.

"1830. General level same as 1828.

"1831. Lower than last year; yearly change at least 3 feet.—Col. Whiting. (Probably an error as this would place the water unprecedentedly low. Col. Whiting probably ascertained that the lake was falling and erred in taking some former high-water mark for that of the preceding year).

Table showing the height of water in the American Great Lakes, measured upward from an arbitrary mark, for the years surrounding periods of maxima and minima in the occurrence of Sun-spots.

Sun-spot Periods.	Year.	Lake Ontario, from Prof. Kingston's Observations.		Lake Ontario, from U. S. Lake Survey Observations.		Lake Superior, from U. S. Lake Survey Observations.		Lake Michigan, from U. S. Lake Survey Observations.		Lake Erie, from U. S. Lake Survey Observations.	
		Yearly means.	Tri-yearly means.	Yearly means.	Tri-yearly means.	Yearly means.	Tri-yearly means.	Yearly means.	Tri-yearly means.	Yearly means.	Tri-yearly means.
Min.	1855	17·8									
	1856	20·6	21·7								
	1857	27·5									
Max.	1859	28·6		30·48		40·32		29·88		33·60	
	1860	18·3	24·7	22·68	28·80	30·24	33·12	23·76	25·92	28·32	30·60
	1861	27·4		33·12		28·26		23·88		29·76	
Min.	1866	9·3		18·36		18·12		3·72		17·76	
	1867	19·7	11.2	28·86	19.20	20·16	18·84	7·68	5·28	18·00	16·56
	1868	4·6		13·68		18·24		4·32		13·80	

Mean of maximum periods in Lakes Ontario, Superior, Michigan, and Eric, from U S. Lake Survey Observations. 29·61
Mean of minimum " " " " " " " 14·97

Difference 14·64

The measurements are in inches and decimals.

"1832. General average 2 feet 10 inches below June 1838.

"1833. General average 3 feet 2 inches below June 1838."

From this date to 1857 many actual measurements are given by Whittlesey, and from these the curve for those years has been constructed. The whole of the observations are reduced as nearly as possible to the average level for each year by comparison with a mean annual curve for about 10 years constructed from monthly averages of bi-five-day means given by the U.S. Lake Survey. 1859 to 1869 both inclusive are from yearly means derived from continuous observations at Cleveland by the U.S. Survey. 1871 to 1873 are from information kindly furnished by Gen. Comstock, Director of the Lake Survey. I have no data for 1870.

The earlier and less systematic observers of the fluctuations of the lakes would scarcely give attention to any but the more important changes of level, and it is possible that these in many cases may have been exaggerated in amount. It would seem improbable, however, from the number of observations which have come down to us, that any variations of importance have escaped notice.

In the upper part of the diagram, the unbroken line represents Carrington's curve founded on the number of sun-spots. The broken line is a reduction of a mean curve based on the area of the spots given by De la Rue, Stewart, and Loewy in the Philosophical Transactions for 1870; and is introduced as showing the solar periods to a later date.

3. *General Remarks.*—The first four maxima of sun-spots represented in the table being separated by long intervals of years with few spots, and not being very intense, would appear to have been closely followed by L. Erie. More especially 1837, the year of greatest known intensity according to both spot curves (333 new groups of spots according to Schwabe), was marked in its effects on the lakes, giving rise in 1838 to the highest recorded level of the waters in Erie and Ontario, and probably also in Superior, though here the data are not so certain. The high-water mark of 1838 has since been employed as the datum to which all the measurements of the Lake Survey are reduced.

The three last periods of maxima of sun-spots are extreme, and the intervals characterised by their deficiency so short that the lakes seem to have been unable to follow them as closely as before. One period of high water being to a great extent merged in the next, and resulting in a general high state of the lakes for the last thirty years, which may be connected with the Wolfian Cycle of fifty-six years in the development of sun-spots, The lakes do not seem to have responded to the maximum of 1848, but by a reference to the curve of area of sun-spots, it will be seen that the intensity of this period was not so great as of those on either side of it, and the period of maximum was maintained for a very short time only. The important sun-spot maximum of 1859-60 was evident in its effect on the lakes even at their present general high level. With regard to the Lake of the Woods the data are slight, but it may be mentioned that this lake is known to have been very low in 1823, and in 1859 to have attained a point which it has never touched since, and which is about 3 feet higher than the present level. The lake is also known to have been for a good many years higher than usual, and at least one well-marked high water took place between 1823 and 1859, which may very probably have been synchronous with that of 1838 on the great lakes. This lake derives its water from the western slope of the same Laurentian range which feeds Lake Superior.

The correspondence between the periods of maxima and minima in solar-spot cycles and in the fluctuation of the great lakes, though by no means absolute, seems to be sufficiently close to open a very interesting field of inquiry, and to show the extension of the meteorological cycle already deduced by Messrs. Meldrum and Lockyer for oceanic areas in the southern hemisphere, to continental ones in the northern.

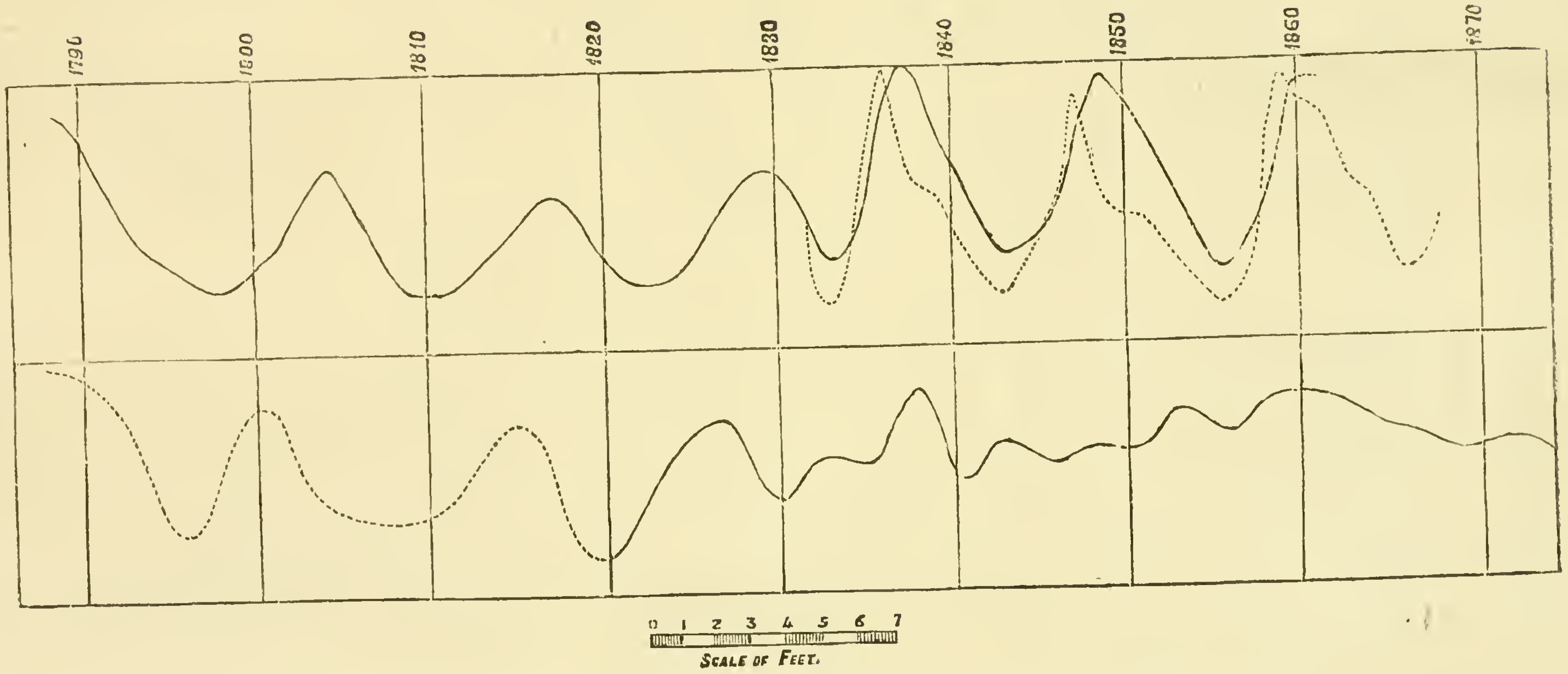
The great lakes in their changes of mean yearly level probably show a very correct average of the rainfall over a large area, and thus indicate the relative amount of evaporation taking place in different seasons. It is to be observed, however, that the actual mean annual outflow of the lakes would be a better criterion, and that from the form of the river valleys giving exit to the waters, this must necessarily increase in a much greater ratio than the measured change of level in the lake itself. It is much to be desired that such observations should be systematically made. The occurrence of seasons of great activity of evaporation and precipitation, as indicated by the lakes synchronously with those of maximum in solar-spot production, would tend to confirm the opinions previously formed as to the coincidence of the latter with periods of greater solar activity. Wolf, as quoted by Chambers, states from an examination of the Chronicles of Zurich, "that years rich in solar spots are in general drier and more fruitful than those of an opposite character, while the latter are wetter and stormier than the former." Gautier, from a more extended series of observations, including both Europe and America, has deduced an exactly opposite conclusion, which, from the evidence of the great lakes, would appear to be the correct one.

It is quite possible, however, that both may be true (see "Solar Physics," p. 430). The great lakes lying at the base of the Laurentides, where moisture-bearing winds from the southward and westward are interrupted in their course, and meet with cold currents journeying over these hills from the north, are essentially in an area of precipitation, and greater precipitation would here be the natural result of greater solar energy. In other regions excessive evaporation may result from the same cause, and this may account for the gradual desiccation which on the authority of many observers is going on at present over great areas of the inland plains of the west.

The observations here given cannot be accepted as conclusive, but derive additional importance from the large area which they represent, and may suggest more systematic investigation of the subject, and the accumulation of accurate observations, which in the course of years may lead to results of greater value.

From *Nature,* April 30th, 1874.

Comparative Diagram of the Fluctuations of Lake Erie, and Periods of greater or less Solar Activity as indicated by the occurrence of Sun-Spots.



1. Solar Spot Curves. 2. High Water, June 1838. 3. Lake Erie.

THE NATIVE COPPER MINES OF LAKE SUPERIOR.

By James Douglas, Quebec.

The Jesuit fathers who, in extending the domain of Christianity two centuries ago, explored and described parts of the American continent, which are still almost as wild as then, likened Lake Superior to a relaxed bow on whose string rests an arrow, the north or Canadian shore being the bow, the south or United States shore the bow-string, and the arrow the promontory of Keweenah, which, protruding from the south shore far across the lake, divides its waters almost into halves. This promontory, while one of the most salient geographical features of the lake, is moreover geologically and mineralogically the most remarkable, for on it, running from end to end, exist in their greatest development those cupriferous beds of trap and conglomerate in which native copper occurs under conditions most puzzling to the mineralogist, and from which it is being extracted in quantities sufficient to supply the growing wants of the United States and to threaten the stability of the copper market elsewhere.

In the present article, it is not my object to discuss the cosmical bearing of the subject, but to describe two of the most noted mines near Portage Lake and the means adopted to extract the mineral from their ores. Nevertheless, a sketch of the geology of the region and of the mining elsewhere in it is necessary as a preface. Lake Superior is framed in primitive rocks. The gneisses and granites of the Laurentian formation at places rise in bold cliffs out of the waters along the east and north shores, and where the shore line in its trend to the south-west leaves the Laurentides, the intervening space is occupied by a narrow belt of Huronian slates and conglomerates, on which seem to rest unconformably, judging from the scanty evidence afforded by the survey of this part of the north shore, but conformably, according to Brookes and Pompelly,* who have examined the lines of contact on the south shore, a series of beds of bluish shale, sandstone, indurated marls and conglomerates, interstratified with trap, which is sometimes amygdaloidal.

Sir William Logan subdivides this great mass of rock, whose total thickness can be but vaguely guessed at, into lower and upper groups, and designates them as the upper copper-bearing rocks of Lake Superior, in distinction to the Huronian or lower copper-bearing series.

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* American Journal of Science, June, 1872.

The lower group occupies the north-western shore of the lake, and sweeps rounds its extreme westerly end, but in the extension eastward of it and the upper group they are divided from the south shore by sandstones of a very different character to those which are interstratified with their own traps and conglomerates. These sandstones, which line the south shore, with but few interruptions, from Sault St. Marie to Duluth, lie in horizontal or very slightly inclined beds, and, being very friable, have been at several spots fashioned by the water into the fantastic forms known as the pictured rocks. Representatives of the same sandstone occur on some of the islands along the north shore, being all that remains above water of the soft formation out of which the bed of the lake was hollowed. But while they yielded to the destructive agency of water, the harder beds of the copper-bearing groups have withstood it, and these, therefore, as on the point of the Keweenah promontory, rise abruptly out of the lake, which has washed away entirely the sandstone from their flanks, or, as towards the base of the promontory, spring at as abrupt an angle out of the horizontal sandstone strata, or else from islands, isolated or in groups, which, however, always bear a marked relation to one another and to the lines of upheaval distinguishable on the mainland.

The lower group of these rocks which we have described as confining the western end of the lake has not produced copper in workable quantities, and differs also in lithological character from the upper group. On the south side of the lake this upper group forms distinct ranges, the more easterly of which are traceable with remarkable parallelism from the base to the point of the Keweenah promontory; and they reappear on the north shore, the more westerly in Isle Royale, in the Thunder Bay and Neepigon promontories, and in the St. Ignace group of islands, the more easterly in Michipicotin and in some of the headlands of the coast.

The age of these rocks is the subject of some difference of opinion. They seem, from the observation of Brookes and Pompelly in Northern Michigan, to conform in strike and dip with the Huronian schists, both uniformly dipping to the north at angles of 50°—70°, and where the Huronian come in contact with the sandstones above mentioned, there is the same sudden alteration in dip as between these same sandstones and the copper-bearing rocks on the Keweenah promontory. Hence, one would infer that the traps and conglomerates of the upper-bearing series come next in age to the underlying Huronian schists, and that subsequently to their upheaval were deposited the sandstones whose horizontality has not been broken by any disturbing force. The sandstones are generally attributed to the lower Silurian system.

Copper explorations on the Keweenah promontory have been made at innumerable spots over a distance of 100 miles along the strike of the beds, between the Point and Lake Agogibic, but the mines which have proved productive are confined to three districts, viz., Keweenah Point or Eagle River, Portage Lake, and Onontagon.

On the Point, the copper-bearing rocks attain their greatest lateral development, and beds of conglomerate, melaphyre, and compact sandstone, with the same dip and strike, stretch from shore to shore. Thence, as they curve round in a south-westerly direction, the range diminishes in width. Some of the first mines opened were on the west coast of the promontory, where, for nearly 30 miles' members of the copper-bearing series form the shore wall.

Here the most productive group of mines is on a system of fissure veins, which cut the rocks of the northern range at right angles to their strike. The Cliff Mine, the first of the lake mines to pay a dividend, and which, from first to last, has distributed nearly $2,280,000 among its shareholders, is on a vein which, though not generally wide, was often filled with mass copper. The copper was associated with quartz, calc-spar, and other vein-stones. The contents of the fissure exhibited a banded structure, and were influenced markedly by the country rock. In this district, likewise, copper was mined from a bed of amygdaloidal trap, here known as the *ash bed*, and work was also done on conglomerate beds; but, if we except Copper Falls and the Phenix Mines, the operations on the fissure veins alone have been financially successful.

While the Cliff Mine near the point of the promontory was the first to prove that the native copper is more than a mineralogical curiosity, the Minnesota, near the south western end of the range in the Ontonagon district, became even more famous from the enormous masses of copper it produced. Here, likewise, the copper occurs in veins which, though running with the strata, are palpably subsequent formations consisting chiefly of quartz, calc spar, and laumonite. The vein stone is different from the enclosing rock, the walls are well-defined and often grooved. In the Minnesota, the masses were not only large, but frequently threw off branches into the enclosing rock, which interfered with their being detached in the usual manner by removing the country rock adjacent. The prosperity of the mine ceased after the extraction of a mass of 90 per cent copper, weighing 525 tons, in 1857. No mines here are flourishing at present, nor does there seem to be a like revival of mining industry to what is taking place in the Keweenah Point district on the *ash bed*, under the infection of the successful development of certain beds near Portage Lake.

Portage Lake and River extend so nearly across the promontory at about 60 miles from its point, that a canal less than three miles long suffices to give water communication between the east and west shores. The lake is an irregularly-shaped body, as much as two miles wide where excavated out of the low-lying sandstone, but tapering rapidly where the high, bluff cliffs of the trap beds of the copper-bearing series confine it. While still in the low-lying horizontal sandstone, it throws off towards the north-east a long arm, which expands into Torch Lake, a considerable body of water whose north-west shore almost defines the line of contact between the horizontal sandstone and the steeply-tilted copper-bearing rocks.

As the steamer enters the narrows, and there come into view the towns of Hancock and Houghton facing one another on the opposite banks, the large mills on the lake shore, and the mine buildings and tramways on the heights above, the contrast between the modes of activity and the aims of civilised man, and of the Indians, with whom the traveller, if he has been long on the lake, must have come into close contact, strikes the mind very forcibly.

Where the copper-bearing rocks are exposed by the deep fissures, whose bottom is occupied by Portage Lake, the width of the range is seven miles, and the beds dip at an angle of 54° to the north-west. They consist of traps of varying degrees of compactness and shades of colours, interstratified with conglomerates and sandstones.

According to Macfarlane, "the constituent of the traps of the Portage Lake District are principally felspar of the labradorite species, and chlorite of a species allied to delessite, with which are found occasionally mica, small quantities of magnetite, and perhaps of augite and hornblende."* He considers the characteristic trap of the region to consist of:—

Delessite	46·36
Labradorite	47·43
Pyroxene	5·26
Magnetite	0·95
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The mines in the immediate vicinity of the Lake are on the amygdaloidal trap. Many have been opened both on the north and south shores, but those only on the Pewabic lode—the Quincy, Pewabic, and Franklin mines—have returned profit to their shareholders. Of these three, the best worked, and therefore most successful, is and has been the Quincy, and we shall therefore describe it as being a typical, though the best example, of its class.

It was opened in 1849, and has been worked uninterruptedly ever since, stemming the tide of low prices when almost every other mine was carried down the current.

The lowest level is at 1330 feet along the dip of the bed, and therefore on the incline of the shaft from the surface, and the longest level is 1600 feet. The shafts and all the workings are opened in productive ground, where that can be followed; but as the walls of the copper-bearing bed are never well defined, and as tracts of rich ground abruptly alternate with stretches of barren rock, there is found considerable difficulty in keeping to the lode, as it is called. Moreover, from being pinched and poor, or even barren, it will suddenly bulge to 20 or 30 feet of rich rock. The hanging *wall* is composed of a fine-grained, compact, bluish trap, but the characteristic trap beneath is coarse-grained and amygdaloidal, and approaches in appearance to the copper-bearing rock.

The copper bed, however, while likewise generally permeated with small amygdules, is of a deeper red and breaks with a more uneven fracture. The minerals which fill the amygdules in the barren bed, viz., quartz, calcspar, laumonite, prehnite, not only fill the amygdules here, but likewise form irregular veinlets rich in copper; and the chlorite constituents of the rock prevail so largely in parts as to give it a deep green shade. Pellicles of native copper enveloped in chlorite often occupy the centre of the amygdules. We see here the tendency of the copper to aggregate with the quartz, and the *same* zeolitic minerals as compose the fissure veins of the Eagle River and the bedded veins of the Ontonagon districts; and, therefore, if we attribute the formation of the one to aqueous agencies, are led to ask whether the same agencies have not had more to do with the formation of the beds and their mineral contents than has generally been attributed to them.

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* Geology of Canada, 1866, p. 152.

Sheets of native copper occur between the joints of the trap in the copper bed, and formed evidently through infiltration, are found also between the trap blocks beyond the walls of the bed. An indication of subsequent aqueous action is seen in the streaks of clay which smear to a great depth the faces of the trap blocks. A single cross course, carrying quartz, but no copper, is said to have been met with. The width of the bed of copper-bearing ground is supposed to be about 70 feet; not that in any place 70 feet of productive rock has been found, but when copper has been lost on one wall, as much as 70 feet have been driven through what is supposed to be the same bed, and copper found in what has been taken for the other wall. More than once, cross cuttings for many fathoms have thus resuscitated parts of the mine where it was feared the copper had given out altogether. The suddenness with which the rock will change and lose its metalliferous character is very remarkable, and affects, naturally, the productiveness of the mine from year to year.

Copper-bearing beds alternate, however, with barren trap for a distance of 500 feet, as determined by a cross cut eastward from the 70 fathoms level of the neighbouring Pewabic Mine. In the report of the agent of that mine, in 1863, he anticipates that the following copper beds would be reached at the distances indicated. The results justified his predictions. From the Pewabic lode, the distances of the adjacent strata were:—

As Anticipated.		As Determined.	
Old Pewabic	148 feet.	Old Pewabic	171 feet.
Green Amygdaloid	285 "	Green Amygdaloid	275 "
Albany and Boston	382 "	Albany and Boston	380 "
Epidote or Mesnard	465 "	Epidote or Mesnard	448 "
Conglomerate	520 "	Conglomerate	500 "

To the West of the Quincy and Pewabic lode, little mining has been done on the lake shore, the Hancock being the only copper-bearing bed extensively worked.

The heaviest copper lies generally near the foot wall. Throughout the region the metal is classed according to its size as mass, barrel, and stamp work. Mass copper is confined to the other districts; but the Quincy Mine yields a certain quantity of barrel work, or copper pieces of such size that they can be separated from adhering rock without the aid of water dressing. The quantity is, however, small, compared with that which is scattered in particles so small that machinery and mechanical concentration alone can separate them from their matrix. The means used to effect the separation are the same in all the mills of the district.

The equipment of the Quincy Mine above and below ground is excellent. The hoisting cars are of heavy boiler plate. Here and at other mines the cars discharge themselves by means of a very simple device. They are shaped like large coal-scuttles, and run on four wheels; but on the same axle, and projecting beyond the back wheels, are wheels of smaller diameter, which, when the car reaches the spot where it is to be emptied, run up inclines secured on each side beyond the track. Thus the back wheels are lifted off the track, while the four wheels remain on the rails and the body of the waggon, tilted forward, shoots out its contents.

Heretofore it has been the custom in the Portage Lake shore mines to calcine the rock, and thus render it more friable; but following the example of the Calumet Mine, a hammer like a pile driver has been introduced into the Quincy ore-house, which reduces the larger blocks to a size suitable to the Blake crusher, and for hand-picking. The ore undergoes the following treatment. Discharged from the hoisting car, it is carried down an incline to the ore-house, which is on the brink of the steep hill overlooking the lake. The ore-house is provided with a hammer, under which, as stated, the largest blocks, weighing often over a ton, are broken. Such blocks require enormous force to shiver them, inasmuch as they are generally permeated with metallic copper in arborescent masses, which so binds the rock together, that even when broken, fresh force has to be used to drag the detached stones asunder. In the ore houses a preliminary hand sorting of the rock takes place before it is further reduced in size by Blake's crushers. Beneath the Blake crushers, other hand pickers are stationed, who separate still more of the barren or almost barren rock; and the ore, reduced in quantity to about two-fifths of what was hoisted out of the mine, is run down the steep inclined tramway to the copper house.

Stamps are used invariably throughout the peninsula for crushing the ore. Cornish rolls have been tried, but without benefit. They become so often clogged with the larger lumps of copper, and, thus kept apart, so much stuff passes through uncrushed, that the quantity of raff was enormous, and the yield of the rolls small. In the Quincy Mill, when running to its full capacity, 70 square shafted stamps, weighing 900 lbs. each, and with a drop of 16 inches, crush 232 short tons of rock, or 3·3 tons per stamp head per diem through screens perforated with $\frac{1}{4}$-inch holes. Two of the batteries are engaged upon the barrel work, which is, by their pounding action, more perfectly freed from rock than it can be in the ore-house, but has, of course, to be removed from the battery-box; and all the battery-boxes have to be cleaned out twice a day. From the batteries the ore passes on to shaking sieves perforated with $\frac{1}{8}$-inch holes, and fine and coarse are further classified before being concentrated by entering with a full stream of water a succession of long triangular troughs which diminish in diameter and depth as size after size is drawn off to its proper hutch. The hutches everywhere used are piston hutches with fixed bottoms; and though in different mills they go under different names, the differences are in reality trifling. Collom's jigs are those most commonly used, and consist of a central piston-box divided into two compartments, each of which is in communication with an adjacent compartment in which the sieve is fixed and into which the copper that passes through the sieve falls. The pistons of the two hutches are pressed down by a single rock shaft, and each piston is lifted back into position by a spring—a desirable motion—as the down stroke is thus sharp and rapid, and the up-stroke slower. But the hutch is open to the objection that, as each piston covers only half the corresponding sieve, a wave is propagated from one end of the sieve to the other, which interferes with the regular subsidence of the ore. As the ore is imperfectly sized, some collects in the sieve and is removed from time to time, but most falls into the bottom, whence it is carried away by the flow of water.

The hutches are arranged, with a view to saving labour, in tiers one below the other, so that the scimpings from one flow into a hutch on a tier below, and the concentrate is re-concentrated in like manner. Water being the carrier, no handling, or very little, is required from the time the ore is thrown into the stamps till it is shovelled from the receiving tank as 80 to 90 per cent copper.

One of the most perfect mills on the lake shore is that of the old South Pewabic mine—now the Atlantic. In it, the stuff crushed by Ball's stamps is concentrated by 112 hutches arranged in seven tiers. There, also, the rotating German buddle is found to save the copper from the slimes effectually and cheaply. In the Quincy Mill, the old-fashioned percussion-table takes out the coarse slimes, and tributers re-treat the refuse from the whole mill in a separate building with English buddles. The coarse concentrate generally runs to nearly 90 per cent of copper, the fine, which cannot be separated, without repeated washing, from the iron—which we have seen is a constituent of the trap matrix—sometimes stands as low as 50 per cent; but all the mills aim at delivering an average of 80 per cent to the smelting works.

Side by side with the Quincy Mill is the Pewabic Mill, in which Ball's stamps are used. A comparison of the tailings from the two mills, made by Mr. Macfarlane, is interesting. He found

QUINCY MILL.

Scimpings from coarse ragging	0·06	per cent
Scimpings from fine ragging	0·73	"
Buddle tailings	0·46	"

PEWABIC MILL.

From head of run	4·93	per cent.
" middle of run	3·00	"
" end of run	3·13	"
" heap outside of run-house	0·66	"
" sand bank	1·00	"

The Ball stamps may influence the result, through the volume of water required for their efficient working, and which, not being separated from the suspended ore, may in some cases flood the hutches.

The annual reports of the Quincy Mining Company are models, presenting the work done and the cost of doing it in clearest detail. From the report for 1872 we summarise the following particulars. During the year, there were stoped 5165 fathoms, and sunk in shafts and winzes 898 feet —say 150 fathoms, and driven 1974 feet—say 329 fathoms. Assuming the specific gravity of the rock to be 2·7, and that therefore there are 18 tons to the cubic fathom, there were broken 101,592 tons of rock. As there were 60,828 tons stamped, about 4-10ths of the rock was separated by hand-picking. The mining, raising, and picking cost for the year amounted to 283,487·30 dols., or 2·79 dols. per ton of rock raised, while the milling cost was 64,783·79 dols., or 1.06 dols. per ton of rock stamped. This large amount of rock yielded 2,804,954 lbs. of concentrated mineral, which produced 2,276,308 lbs. of ingot. There was recovered, therefore, only 1·12 per cent of copper from the rock mined, and yet there were divided, as the year's profits on working, 210,090 dols.

In 1872, copper brought an exceptionally good price, selling at 32⅓ cents per lb., but as a set-off, wages were high, the average wage of miners on contract being 60·62 dols., and the yield of the ground per fathom lower than its wont.

Distributing the cost over the mineral produced, we find that, as 2,804,954 lbs. of mineral—which, without making an allowance for the slight loss in smelting, must have contained 81·1 per cent of copper—were obtained at a cost for mining and concentrating of 461,147·83 dols., each pound cost 16·44 cents; but when the cost of smelting, transport, insurance, and commission was added, each pound of ingot cost 22·93 cents U. S. currency, or, say, 20 cents in gold. Copper has fallen to 25 cents U. S. currency, but as wages have declined proportionately, and the cost of production therefore has been lessened, there is not likely to be a very serious decrease in the profits. Besides distributing this large sum among the shareholders, there were added to construction account,—for permanent improvements likely to lessen the cost of future production,—67,227·65 dols., so that the real profits of the year were 277,318·35 dols., which certainly could have been realised only by good management and by the employment of every possible labour-saving appliance for the working of an ore yielding but 1·1 per cent of copper.

Another mine even more interesting to the mineralogist, and more startling in its yield, is the Calumet and Hecla. It is situated 13 miles from Portage Lake, in a north-east direction, on a bed of conglomerate, which, however, it is not easy to identify with any of the beds that abut on the lake, as the range widens as it approaches the Point and the beds flatten. While the mineral range at the lake is 7 miles across, at the Calumet and Hecla it is 13 miles wide, and the dip declines from an average angle of 54° to 38°. Copper had been extracted from conglomerate beds before the opening of this mine, but never with good financial results. From the Albany and Boston Mine, where both a conglomerate and an amygdaloidal bed are worked, specimens very similar to the rock since yielded by Calumet were obtained; but the failure of this and other mines led to a distrust in, and a too hasty condemnation of, conglomerate mines. It is to be feared the opposite error may now be run into.

The Calumet Mine was discovered about 13 years ago. An inn, the half-way house between Hancock and Eagle River, stood in the forest near where the mine is now, and was kept by a Cornish man. His pig—so tradition tells—fell into a pit, which proved to be an old Indian working. It was dragged out so besmeared with green that the owner at once suspected the existence of copper. Since then, two little towns,—Calumet and Red Jacket,—have sprung up, and as great a change has taken place beneath the surface of the soil. Two mines on adjacent locations, though in the same bed, viz., the Calumet and Hecla, are owned and worked by one company. This mine has now reached a depth of 1060 feet on the incline of the bed, or 600 feet vertical, and one of the upper levels is 3000 feet long. Most of the copper comes from a bed of conglomerate, in which a hard red porphyritic pebble is embedded in a cement of the same rock, and of native copper. The pebbles in the rich rock are smaller and more rounded than beyond the rich chimnies. The pebbles composing the conglomerate are seldom themselves cupriferous, though some of them are. I have a large pebble from the conglomerate bed which is identical in appearance with the compact chocolate-coloured rock of the Quincy Mine, and is throughout permeated with a little copper in the same manner as the rock, but for a depth of about two lines from the surface it is ensheathed in fine-grained copper, which, as well as the copper permeating it, may have penetrated the pebble or been deposited around it,—it is difficult to say which. In the conglomerate also occur boulders of solid copper. Some are said to exhibit a concentric arrangement of the copper, but one I had cut through the centre was homogeneous in structure, but contained, embedded in the copper, a few crystals of quartz and felspar.

Interstratified with the conglomerate are thin bands of copper sandstone, the copper being in fine grains, sometimes deposited pure, at others mixed with epidote and quartz or finely-ground porphyry, the laminæ easily separable from one another. In their midst are sometimes embedded pebbles of copper. Bands of hard compact sandstone, from the disintegration of the same rock as compose the conglomerate, are met with beneath the foot wall, on the hanging wall, or in the bed itself. A specimen in my possession exhibits successive layers firmly compacted, some of conglomerate, others of coarse-grained and others of fine-grained sandstone, with a surface distinctly ripple marked. The aqueous origin of the bed cannot be doubted, but whether the copper was mechanically or chemically deposited, it is more difficult to decide. The easier explanation of its occurrence is on the hypothesis of a mechanical deposition, but, as militating strongly against it, is the undoubted fact that the conglomerate pebbles very rarely carry copper. The effects of subsequent chemical action are beautifully exhibited in a clay *flucan* which, from the surface to nearly the lowest level driven, lines in places the foot-wall. In it, embedded in soft clay, derived from the disintegration of the rock, and which harden into a mass that might almost be mistaken for a piece of trap, occurs with calcspar, laumonite and quartz, copper in dendritic masses, distinctly crystallised. Some of the specimens taken from the flucan undoubtedly exhibit instances of false crystallisation, plainly showing the impress of the crystals amidst which they were formed, but others are as undoubtedly themselves crystallised. *Vugs* also occur lined with crystals of epidote, and calc spar, and spongy copper; and through the bed there passes diagonally what is called a dropper. It is only a few inches wide, but consists of what is locally called brick copper, which is accompanied by crystallised silicated minerals, entangled in which are conglomerate pebbles. It has unmistakable *slickensides,* on which the copper is actually polished.

A bed of amygdaloidal trap overlies the conglomerate, and is in places rich in copper. Some of the amygdules are completely filled with copper, in others a small nucleus of copper is enveloped in calc spar or epidote, while a coating of red ferruginous-looking earth lines the cell. A trap, similar in appearance, is worked by the South Pewabic Mine on Portage Lake, but there its richness is deceptive, for the copper forms in this shell only around an earthy nucleus.

The long levels of the Calumet and Hecla run through three rich chimnies of conglomerate, the longest about 1300 feet. They dip to the north, and are widening out rather than otherwise in its lower levels. Between these rich streaks, large tracts of which will yield a 20 per cent ore, are others of poorer ground, and others still almost barren, which are left standing. The average width of the productive portions is 13 feet.

There are broken, raised, and concentrated 740 tons of rock a day. To handle such a large quantity, work has necessarily to be thoroughly systematised both below and above ground, and machinery utilised to the utmost.

Each mine possesses six shafts,—or twelve in all,—eight only of which are connected by levels, and four only used as hauling shafts. The shafts are sunk at 400 feet apart, and levels are driven every 90 feet. Between each two shafts two winzes are sunk, and three stopes 30 feet high are opened on each side of each winze, so that eighteen stopes are worked between each two shafts. Six feet of ground are left standing on each side the shafts, and a heavy arch below each level supports the roof, and gives firm foundation to the road-way. A wall of heavy stulls provided with gates at every 10 feet protect the road-ways, and allow large accumulations to be made in the stopes. Timbering is a heavy item of expense, as the trap which composes the roof is very liable to fall out in pyramidal blocks. The mine-work is done by contract,—stoping by the fathom, drifting and sinking by the foot. The contractor must deliver his rock at the nearest hauling-shaft. The traps are 4 feet apart in the levels, and 4 feet 4 inches in the shafts, as the cars have to be large to receive the heavy blocks which break away in the stopes. The miners are allowed to send to the surface blocks not over 1 ton weight, but the cars are constructed to hold 2 tons.

Drifting is done with great economy, by machine-drilling. Seven Burleigh drills of large size, with 2-inch bits, are steadily at work in each mine, and it is found that with them a drift 10 feet wide can be driven at 8·00 dols. less per foot than a 6-foot drift by hand-labour. This calculation leaves out, however, the cost of the motor power. In the Quincy Mine, the same drills are being thrown aside as uneconomical,—a discrepancy in result which may be accounted for by the fact that in the Calumet there is a well-defined selvage, whereas in the Quincy the drifts are run through solid rock, and grooves must be scooped out beneath the face of this advancing drift,—an operation not easily performed with a cumbrous drill.

The ore is broken in two ore-houses, each of which is provided with a pile driver to shatter the large masses—a Blake's crusher with 18 by 24 inch opening, and six smaller Blakes, with 8 by 15 inch openings, but no attempt is made at selecting by hand, but all the ore raised passes to the mill.

From the crushers the ore falls into huge hoppers, whence it is discharged as called for into the railway cars. All the appliances, in fact, are on a scale such as we are in the habit of associating with iron mining. A five-mile railroad unites the concentrating works on Torch Lake with the mine, and over it two hundred car-loads of 4-ton capacity each are carried daily.

The mills present no feature of special interest. In one are three of Ball's stamps, and in the other four. Six of these powerful machines are running regularly, and crush up the whole yield of the mines. To each stamp there are assigned 20 jigs.

The stamps are steam-hammers. The slide valve is worked by eccentric gearing, and the piston-rod is inserted into the head of the shaft, which is 9 inches in diameter.. The stamp-head is 22 by 14 inches, and weighs 6 cwts. Its upper surface is provided with a bevelled ridge, which slides into a slot in the bottom of the shaft, and is then keyed home. When working on the amygdaloidal trap, Ball's stamp heads, made with white iron and a small percentage of Franklinite and tough pig, last a month. At the Calumet Mills they are worn out in six days, but the renewal involves a stopping of a stamp of only 50 minutes. Each stamp works in a separate stamp-box, which is five-sided, and discharges from three sides through steel plates, perforated with 3-16th inch holes. Each stamp can crush daily 120 tons of this exceedingly hard rock, and is said to consume 25 horse-power; 3000 gallons of water a minute are pumped to the two mills. The great advantages of using the stamp are that so much work can be done with so little machinery and in so contracted a space, and that so little time is occupied in repairs. The Calumet Mills never stop. The Quincy mill is idle for about one month out of twelve.

The scimpings are not clean. They carry from 1·40 per cent. to 1·80 per cent of copper, 0·40 to 0·80 of which is as oxide. Twelve tons of copper, therefore, are thrown away daily.

The Calumet Company publishes no report, but the following figures are, if not quite, very nearly correct. There are 1600 hands employed, 260 contracts are set in the Calumet, and a somewhat greater number in the Hecla. The cost of breaking a fathom of ground varies from 20·00 to 22·00 dols., and it yields 21 tons of rock; the cost of dressing exceeds that at the Quincy mine, standing at 1·17 dols. per ton. In 1872 the mine produced 9717 tons of ingot. The quantity of ore raised daily was about 740 tons, or 266,400 tons per year of 360 days; and, therefore, as it produced 9717 tons of ingot, the ore actually yielded 3·6 per cent of copper. This large amount of work was rewarded by profit in proportion; for there was distributed among the shareholders, in 1872, 2,750,000 dols.; and during that same year large sums were expended in permanent improvements. The result in every respect is unparalleled in the history of copper mining; and all owners of copper mines with no such brilliant promise can only hope that it may not be repeated; for the effect of a very few such mines would be most depressing.

Adjoining the Hecla another mine is being opened by the Osceola Mining Company, which, from surface indications, will be very rich. The Allonez near by is expected to turn out well, and on the Isle Royale attention is again being given to long-neglected conglomerate beds, and the prospects of success is there good also. The Royale, though belonging to Michigan, lies close to the Canadian shore. As already pointed out, the copper formation is largely developed from Michipicoten to Thunder Bay on the main land and on Canadian Islands.

With the experience gained on the south shore, explorations could now be conducted on the north, with better chance of success than heretofore. What little has been done has revealed the existence of deposits that would not have remained unworked had they been situated on the opposite shore.

The following statistics, officially correct, are taken from the annual circulars published by the "Portage Lake Mining Gazette."

The production of all the mines on the promontory for the year ending Nov. 30, 1873, was as follows:—

	Tons.	Pounds.
Calumet and Hecla for year ending Nov. 30, 1873	11,551	1,938
Quincy, for year ending Nov. 30, 1873	1,680	180
Franklin Pewabic	671	1,673
Houghton	285	—
Schoolcraft	270	1,520
Concord	72	—
Isle Royale	143	1,417
Atlantic, for broken season	464	701
Albany and Boston, broken season	50	—
Sumner, for year ending with close of navigation	77	—
Other sources	8	—
Total	15,194	1,429
Production in 1872	12,612	319
Increase in 1873	2,582	1,110

Keweenah Point District.

Central, for year ending Nov. 30, 1873	1,081	1,983
Copper Falls, for year ending with close of navigation	834	927
Phenix	350	—
Cuff	279	1,264
Delaware, for year ending Nov. 18, 1873	55	742
Amygdaloid, broken season	19	303
Other sources	2	184
Total	2,781	1,903
Product in 1872	1,836	894
Increase in 1873	945	1,009

Ontonagon District.

	Tons.	Pounds.			
Ridge	150	113	Knowlton	39	1,864
National	131	318	Rockland	16	460
Minnesota	103	1,700	Mass	6	868
Flint Steel	45	1,356	Adventure	3	1,238
Bohemian	40	500	Tremont	—	700

Total	537	1,117
Product in 1872	725	1,000
Decrease in 1873	187	1,883

Recapitulation.

	Tons.	Pounds.
Portage Lake District	15,194	1,429
Keeweenah Point District	2,781	1,903
Ontonagon District	537	1,117
Grand Total for 1873	18,514	4,449

Or about 14,811 tons of ingot.

The Copper Mineral (of about 80 *per cent.) produced from* 1845 *to* 1874.

1845 to 1854	7,642
1854 to 1858	11,312
1858	4,100
1859	4,200
1860	6,000
1861	7,500
1862	9,962
1863	8,548
1864	8,472
1865	10,791
1866	10,376
1867	11,735
1868	13,049
1869	15,288
1870	16,183
1871	16,071
1872	15,166
1873	18,514
Total	194,909

About 150,575 tons ingots; value about $82,000,000.

In 1872 there were distributed in dividends—

Calumet and Hecla	$2,750,000
Quincy	350,000
Pittsburgh and Boston (Cliff)	100,000
Central	80,000
Minnesota	50,000
Franklin	20,000
Pewabic	20,000
National	20,000
Total dividends	$3,390,000
Total assessments	190,000
Excess of dividends over assessments	3,200,000

The same mines have been remunerative from their openings and have yielded 11,810,000 dols.

The paid-up capital on the same mines amounts to the trifling sum—

	Dollars.
Calumet and Hecla	800,000
Quincy	200,000
Pittsburgh and Boston	110,000
Central	100,000
Minnesota	436,000
Franklin	370,000
Pewabic	235,000
National	110,000
	2,361,000
Increase of dividend over assessments,	9,449,000

There is, of course, another side to the picture. Of 111 mining companies formed, only the eight above enumerated and the Copper Falls Company have paid dividends. Many of the companies were organised to work locations where there was no copper at all, and others failed through ignorance and bad management. The total amount levied, as far as can be ascertained, has been 19,296,500 dols.

All the copper produced in the Peninsula is smelted at Hancock on Portage Lake, or at Detroit, branches of the same establishment. Detroit takes the mass copper from the Keweenah and Ontonagon Districts, as the furnaces there are constructed to receive it. The roof of the reverberatories are lifted, and masses of 10 tons lowered on to the bed, when the roof is replaced, luted down, and the fires lighted. In the Hancock establishment only the barrel and stamp work of the Portage District is treated.

The mineral from each mine is smelted apart, and the copper returned in ingots; 18·00 dols. per ton being charged for the first smelting, and 12·00 dols. for every ton of slag and coarse copper re-smelted..

In the Hancock establishment there are seven reverberatories and two cupola furnaces.

The copper is smelted without any flux in the reverberatories, in charges of 16 tons. Eight to ten hours are occupied in running down, two to three hours in poling, and three hours in ladling out. When pressed for time nine charges are smelted a week.

The product is about 78 per cent of the copper as ingot, a rich slag which is returned to the reverberatory, and a poorer slag which is re-smelted in Mackenzie's blast-furnace with lime as a flux. The valuable product from the cupola is a coarse copper of 85 per cent, which is treated in the same manner as the crude mineral, and a poor slag carrying not over 3-10ths per cent of copper.

One thousand pounds of coal are said to be consumed in the reverberatories to every 2000 lbs. of mineral smelted. Poling is done with birch rods. At Detroit, when poplar could no longer be obtained, oak was substituted without affecting the toughness of the metal.—*Quarterly Journal of Science.*

NOTES ON THE MARINE FISHERIES, AND PARTICULARLY ON THE OYSTER BEDS, OF THE GULF OF ST. LAWRENCE.*

By J. F. Whiteaves.

The following notes are, to a large extent, a compilation of scattered items of information, gathered from various persons residing along the coast. Captain J. N. Purdy, who commanded the *Nickerson* during the first three cruises, and who has had great experience as a fisherman, both in Canada and in the United States, has helped me very considerably in the preparation of this part of my report; and to him I am indebted for most of the facts subjoined. The late M. H. Perley's Report on the Sea and River Fisheries of New Brunswick, published at Fredericton in 1852, contains a valuable amount of local information not to be met with elsewhere. These notes may be looked upon as supplementary to that useful volume. The classification adopted is essentially that of Dr. Gunther's Catalogue of Fishes, in the British Museum. Professor Theodore Gill has published a critical "Synopsis of the Fishes of the Gulf of St. Lawrence and Bay of Fundy," in vol. ii., new series of the "Canadian Naturalist." As this latter paper is probably more accessible than Dr. Gunther's elaborate work, the names given by both authorities are quoted here. References are made only to those fishes or invertebrates which are of some economic importance.

Mackerel.—*Scomber, scomber*, Linn., and *S. pneumatophorus?* De La Roche. Gunther. *Scomber grex*, Mitchill, Gill.

For the last four years mackerel have re-appeared in White and

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* From the Sixth Annual Report, published by the Department of Marine and Fisheries, Ottawa, 1874.

Green Bays, on the north-east coast of Newfoundland. They have been caught in Bras d'Or Lake, Cape Breton, with herring nets, in winter; also at Port Hood, Cape Breton, in December. During the first year mackerel grow to five or six inches in length. The "tinker mackerel," spoken of by Perley, are the fry of the common species, which, in the second year, attain a length of 10 inches. In the Bay des Chaleurs mackerel spawn in May and June, and occasionally a few as late as July. This fish prefers a rocky bottom, particularly banks; it does not apparently dislike sandy ground, but seems to avoid muddy bottoms. Ground *Menhaden* are largely used by American fishermen to bring mackerel to the surface. The Lower-Canadian fishermen use first coarse salt, and then ground fresh herring, for the same purpose. French Canadians do not seem to understand the proper mode of curing mackerel. They split them the wrong way, do not soak them enough, or kill them at once. This is unfortunate, as mackerel often abound in the northern part of the Gulf, especially in Gaspé Bay, and these badly-cured fish are quite unfit for the market. It is said that the use of purse *seines* for taking mackerel is a very wasteful mode of fishing, as more are often caught than can be cured, and quantities are killed unnecessarily this way. It might possibly be desirable to prohibit the capture of spawn mackerel.

TUNNY, or HORSE MACKEREL.—*Thynnus thynnus*, Linn. Gunther. *Orcynus secundo-dorsalis*, Storer. Gill.

Occasionally eaten on the North Shore and on the Labrador coast. A fish largely cured in the Mediterranean, but never, so far as I can learn, prepared for the market by Canadians.

TAUTOGA, or BLACK FISH.—*Tautoga onitis*, Linn. Gunther and Gill.

A delicious table fish, but too rarely found to be of much practical value. Very rarely taken at St. John, New Brunswick, and in the Bay of Fundy.

COD.—*Gadus morrhua*, Linn. Gunther and Gill.

Codfish appear to leave shallow soundings and the inshore banks in winter, and go farther out to sea. A large school visits the east coast of Cape Breton, from Chetigan, round by Scatari, in April. Cod appear to spawn all the year round, even in winter. Schools have been taken spawning on Brown and George's Banks, in February and March, also in November and December in the Bay of Fundy and elsewhere. A few codfish are taken now and then in Gaspé Bay in winter. It is not an uncommon circumstance for a school of cod to follow herring as far as Mahogany Islands, at the entrance of St. John Harbor, New Brunswick, in February and March, where they are taken plentifully with trawls by the inshore fishermen. This school does not apparently strike in shore during the summer, at least not in New Brunswick. A peculiar variety of this fish, "with a dark back and a black ring round the jaws" (Purdy) is taken on the Orphan and Bradelle Banks, as well as on the east coast of Prince Edward Island. They are of a large size and will, it is said, only take the hook *at night*, hence they are known to the fishermen as "night fish." With the exception of haddock, cod is the only fish that is well cured in the northern part of the Gulf. Cod prefer a bottom of stones, gravel, or sand, especially where shells and crabs abound. The season for cod, north of the Bay des Chaleurs, is from about May 15th to November 15th. In Bras d'Or Lake, Cape Breton, also on the north coast of Newfoundland and in the Bay of Islands, cod and herring are caught in winter through holes cut in the ice. The "bull-dog" cod, spoken of by Perley, are supposed to be individuals which have been bitten when young by other fish. A prejudice seems to exist along parts of the coast against the use of "trawls" or bultow lines, but I have not heard of any that appear to me sound arguments against them. It is believed by many experienced fishermen that quantities of young cod are annually destroyed by drag seines, used for bait near shore, but it is not easy to suggest a remedy for this state of things. The clam, of which Perley says the cod are particularly fond, is *Cyrtodaria siliqua*.

HADDOCK.—*Gadus æglefinus*, Linn. Gunther. *Melanogrammus æglefinus*, Linn., sp. Gill.

Most plentiful on the south and west coast of Nova Scotia, and on the west coast of New Brunswick, but common throughout the Gulf. This species is taken all the year round, generally in schools alone, but sometimes associated with cod. They frequent clam banks, in from twelve to eight fathoms. A very valuable market fish, and one which will be much more so when the Intercolonial Railway is opened. At Digby, St. Andrew's and Western Isles, "finnan Haddies" are prepared for various markets in Canada and the United States. Haddocks are taken on the west coast of Newfoundland in winter.

POLLACK.—*Gadus virens?* Linn. Gunther. *Pollachius carbonarius*, Bon. Gill.

Although this fish is commonly called "pollack" by the fishermen of the lower provinces and by those of the United States, it is not the same as the pollack of Europe. Its proper name is the coal fish, and it is common to both shores of the Atlantic. The species is locally known as the "sea-salmon," and is of somewhat southern distribution. It does not appear to range farther north than the Bay des Chaleurs, if so far, and has never been taken in the waters of the Province of Quebec. The species is most frequent in tideways in Nova Scotia and New Brunswick. As a table fish it is preferred by many to cod. To the north of the North Cape of Prince Edward Island no great business is done in the curing of pollack. They are, exceptionally, caught in winter among cod. They are not often taken on banks, but mostly along the shore. They school like mackerel, and are caught at the surface, to which they are brought by ground bait. Their food is said to consist largely of herring. The livers of this species yield the best oil; it is used for machinery and in making leather. Salted and dried pollack is worth from $2 to $3 per quintal.

"Old English Hake."—*Merluccius vulgaris*, Flem. Gunther. *Merlucius bilinearis*, Mitch. Gill.

The fishermen of the lower provinces endorse Dr. Gunther's view that this species is identical with the true hake of Europe. Locally it is called whiting, though the whiting of English authors (*Gadus merlangus*) is a very different fish. Hake are caught in purse seines, also in herring and pogy nets. They are not much used for food, and are rarely if ever cured.

American Forked Hake.—*Phycis Americanus*, Storer. Gunther. *Phycis tenuis*, Gill.

This fish is the "ling" of the Jersey merchants. The species of forked hake in the Gulf require careful examination, as there are as many as three species in that region. On the east and west coast of New Brunswick, and on the north of Nova Scotia, the "ling" is taken from July to November. It is common on muddy bottoms throughout the Gulf; is salted and dried, with very little sun, exported to the United States, and from there to South America.

The Torsk, Tusk, or Cusk.—*Brosmius brosme?* Linn. Gunther. *Brosmius Americanus?* Gill.

The common cusk of the St. Lawrence is taken all the year round, especially in the Bay of Fundy, where the fish occurs in many localities. Cusks are dried and cured with codfish, and fetch a better price than the latter in the West Indian market. There are two species of cusk in the St. Lawrence, but their geographical range has not yet been accurately defined, and I am not sure which of the two kinds is the one most frequently used.

HALIBUT.—*Hippoglossus Groenlandicus?* Gunther. *Hippoglossus Americanus*, Gill.

The Canadian halibut are said to frequent the outer banks in winter and the inshore fishing grounds in spring and summer. They feed on shells, crabs, lobsters, sculpin, &c., and can hardly be caught in quantity except by trawling. They are highly prized by inland consumers, and fetch a comparatively high price. About August halibut are caught in large numbers to the north of Anticosti. They are generally sold by draught (of 224 pounds) and sent to Quebec.

FLOUNDER.—*Pleuronectes Americanus*, Walb. Gunther. *Pseudopleuronectes Americanus*, Walb., sp. Gill.

A common fish everywhere in the Gulf, and occasionally exposed for sale in the markets at Halifax, Nova Scotia.

SMELT.—*Osmerus viridescens*, Lesuer. Gunther. *Osmerus mordax*. Mitchell.

This delicious little fish is, or may be, taken abundantly throughout the Gulf all the year round. In Gaspé Bay smelts are caught in winter like tommy cods, through holes in the ice. In New Brunswick and Nova Scotia smelts are exported to New York and Boston. The species appears to spawn in April and May, and extends up the River St. Lawrence, at least as high as Quebec, in the spring and autumm.

CAPELIN.—*Mallotus villosus*, Mull., &c.

The habitual use of this fish as manure, along the coast, is considered objectionable, as it tends to drive the cod further out to sea.

HERRING.—*Clupea harengus*, Linn. Gunther. *Clupea elongata*, Lesuer. Gill.

In Gaspé last year the first herring of the season appeared about the 25th of April. The fishing began about the 10th of May and lasted until about the 25th of June, after which capelin struck in for a week or perhaps eight or nine days. The "drifting" season in and just outside of Gaspé Bay usually commences about the middle of June, and lasts to the end of July. At

Grand Manan Rips, Captain Purdy informs me, the use of brush weirs has destroyed one of the most valuable herring fisheries in the Gulf. The herrings once caught there were the largest and fattest, and fetched the best price of any in the Dominion. In the opinion of Captain Purdy, the use of drag seines and of brush weirs should be prohibited. At Grand Manan, Campo Bello, and Deer Island, the destruction of young herrings by brush weirs has driven the cod from those localities. The New Brunswick winter fisheries are, or were, an important source of wealth to that province. As many as eighty vessels loaded with fish at West Isles, New Brunswick, for United States Ports, from October, 1872, to April, 1873. In April, 1873, forty sail of United States fishermen came to St. Andrew's Bay, New Brunswick, to buy herring for bait on the inshore bank fisheries. It is feared that the use of purse seines will either destroy or materially injure the herring fishery. In winter the New Brunswick herring frequent river estuaries and harbors with muddy bottoms. The rigorous protection to spawn herring at Grand Manan and St. Andrew's Bay is undoubtedly a great public benefit. For many of these details I am indebted to Captain J. N. Purdy.

MENHADEN, OR "POGY."—*Clupea menhaden*, Mitch. Gunther. *Brevoortia menhaden*, (Mitchell) Gili. A fish of very rare occurrence in Canadian waters. Of late years none have been found in New Brunswick or to the north of Grand Manan. Menhaden are largely used as bait for mackerel, cod, and halibut. The head, tail, backbone, and offals of this fish are converted into manure by grinding, pressing, and adding a little salt to them so as to make a kind of guano. In the United States this preparation is worth from $16 to $20 per ton. Iced menhaden is used as bait for cod and halibut, and the meat of the same fish salted and subsequently finely ground is employed to bring mackerel to the surface. The United States method of fishing for mackerel is greatly disliked by fishermen resident along the coast. The effect of it seems to be to draw mackerel further out to sea, and it seems tolerably certain that in many bays, as in some of those of the East coast of Cape Breton, for example, no mackerel are found now where they formerly used to be plentiful. At the same time the use of menhaden is not illegal, and United States fishermen always were allowed to take mackerel (except inshore) before the fishery clauses of the Treaty of Washington came into force. It would be desirable perhaps to try and acclimatize menhaden in British waters. All that would be necessary would be to send a vessel or two, each provided with a well room, to the United States, and liberate the menhaden thence procured, at the mouth of any of the New Brunswick or Nova Scotia Rivers, such as St. Andrew's Bay, L'Etang, Lepreaux, or Musquash, in New Brunswick; or St. Mary's Bay and its tributaries, or Tuskeet River, in Nova Scotia.

The Lobster. *Homarus Americanus,* Edwards. The lobster fisheries of the River and Gulf of St. Lawrence, are of very great economic importance, more especially now that the supply of this popular article of food is not equal to the demand for it in the United States and in Europe. At present large quantities of lobsters are shipped to these countries from New Brunswick and Nova Scotia. In spite of their increased commercial value, it is nevertheless a fact that in some of the northern parts of the Gulf good marketable lobsters are still used to manure the fields! Few can doubt the propriety of at least attempting to discourage a proceeding at once so reprehensible and wasteful. The latest regulation, forbidding the taking of lobsters less than a pound and a half in weight, is much complained of by persons engaged in this fishery. They urge that it would be better to allow lobsters weighing a full pound to be taken, but not any under that weight. Mr. W. S. Brown, who has a lobster canning establishment at Shippegan, has kindly given me an account of some of his experiences during the past summer. He says that a few small red eggs begin to form under the tails of the lobsters early in July, and at the end of September the tails were filled up, and 80 or 90 per cent. of the lobsters taken had eggs attached to them. Late in September these eggs had become nearly the size of B.B. shot, and were very dark in colour. At this time the few that were taken near the shore were mostly males. Mr. Brown thinks that the lobsters leave the shore in October, and go to deposit their eggs in deep water, and that this latter operation is performed sometimes as late as November or December. In July and August, Mr. Brown writes me, "I found that 80 to 90 per cent. of the lobsters had an abundance of eggs, and that 60 to 70 per cent. of them would weigh less than a pound and a half. Five lobsters weighing 1½ lbs each will shell out about one pound of fish, and my average this season has been about four and a half lobsters to the pound or can." "The heavy gale of last August drove more lobsters ashore within five miles of my packing houses than I could make use of during the whole summer." "They formed a row of from one to five feet deep, and I should estimate them at an average of one thousand to every two rods of shore." "The next that came in shore after these were very small, averaging from two to four inches in length, and upwards, and the coast seemed alive with these small lobsters." It might be desirable to establish protected breeding grounds for lobsters in the Gulf, on somewhat the same general principle as oyster beds are formed. The season for lobsters varies with the locality. In Gaspe Bay they are taken in July and the beginning of August, but further south they appear earlier and stay later. In the southern part of the Bay des Chaleurs and on the northern New Brunswick coast, they approach the shore late in May, and leave it for deep water more or less late in September. There seems to be a great difference of opinion among the coast fishermen as to the time when lobsters spawn. Very small specimens, always less than an inch in length were frequently taken by the towing net in July and August at some distance from land, swimming about among floating weed. The Hon. W. H. Pope writes me that lobsters often burrow in the sides of oyster beds during the winter months.

Canadian Oysters. *Ostræa Virginiana*, Lister: and *Ostræa borealis*, Lamarck. It is not necessary or desirable to enter minutely here into the somewhat complicated history of the synonymy of the two Canadian species of oyster. It is sufficient for my present purpose to say that the long and narrow oyster, which is abundant in Virginia, New York Bay, &c., was the first of the oysters known in Europe from the temperate parts of North America. The species was known to Linnæus, and was originally described by Lister as *Ostræa Virginiana*. For the shorter and more rounded form, Lamarck at a later date, proposed the name of *Ostræa borealis*, and gave a short diagnosis of the species. Some varieties of this latter mollusc came so near to specimens of the common British and north European oyster, that it is difficult to distinguish between them. *Ostræa Virginiana* is much the rarest of the two Canadian oysters, but between it and the *O. borealis*, there are so many intermediate varieties and connecting links, that many naturalists doubt the value of the specific relation proposed.

As the geographical range of the two forms is very similar, and as my principal object is to call attention to their economic importance, the two species, or varieties, will be considered together. In the Gulf of St. Lawrence, oysters are usually found in very shallow water, nearly always in depths of less than three fathoms, in sheltered bays or mouths of rivers. In New Brunswick, as has been shewn before by Perley, they range from Caraquette to Baie Verte. Capt. Purdy informs me that oysters have been taken up on the flukes of anchors, in 7 fathoms water, between Little and Big Caraquette Banks, in the Bay of Chaleurs. On the coasts of Prince Edward Island, oysters are found in suitable localities, from Pinette River to the west point on the Northumberland Straits side; and in Malpeque or Richmond Bay, from Cascumpeque to New London on the northern. In Cape Breton they appear to be confined to Bras d'Or Lake and its tributaries, where the oyster region extends from St. Ann's to Mira River and St. Peter's Bay. The few oysters to be met with off Nova Scotia, occur at Jeddore Head, 20 or 25 miles east of Halifax Harbor, also Country Harbor, St. Mary's River and Lipscombe Harbor, Guysboro' Co., on the outside; and Pictou Harbour, River John, Wallace, Charles River, and Pugwash, in Northumberland Straits. (Purdy.) We did not find traces even of oysters in any part of the area between Cape Breton and Prince Edward Island, nor in any part of Northumberland Straits where the bottom is deeper than five or six fathoms, that is to say not in any of the open parts.

In answer to a letter asking for information on several points connected with the oyster beds of the Gulf, the Hon. W. H. Pope has kindly given me a most interesting and valuable account of the oyster beds of Prince Edward Island, together with many items of practical information on the subject, which no one else is so well qualified to give. The following paragraphs, to which quotation marks are affixed, are extracts from letters received from Mr. Pope, and are printed by his permission.

"Oysters *have* flourished is every tidal river and bay in Prince Edward Island. At the present time, productive oyster beds are found in Richmond, Cascumpec, and Hillsborough Bays, and in the rivers flowing into these inland waters. I might almost say in these localities alone. The produce of the beds in Hillsborough Bay is very inconsiderable. The official returns of imports and exports to and from Prince Edward Island, for 1872, shew that 9,490 barrels of oysters were shipped from this Island in the previous year."

"From Summerside,	7,572	barrels	Produce of Richmond Bay.
" Malpec,	840	"	
" Cascumpec,	718	"	" Cascumpec Bay.
" Charlottetown,	230	"	Chiefly produce of Richmond Bay.
" Orwell,	130	"	

"The dredge has never, to my knowledge, been employed in the waters of Prince Edward Island. Oysters are fished with "tongs," from depths varying from three or four feet to twelve, and even fifteen feet. It is scarcely practicable to fish oysters, with tongs, at a depth greater than fifteen feet."

"I am not aware of the existence of oyster beds in any part of the Straits of Northumberland, or of the sea surrounding the Island. Some years ago I observed a quantity of oyster shells on the sand at the north end of the Tryon Shoals (which are situated on the south side of the Island); they were about a quarter of a mile from the shore. Some of the shells were filled with sand, more compact than much of our sandstone rocks. When I first observed these shells, my opinion was that they had been washed ashore from beds situated in the deep water of the Straits of Northumberland. It has since occurred to me that they are *in situ*, and are the remains of an ancient oyster bed which had been destroyed by the sand. The existence of a soft muddy bottom in the vicinity of these shells supports the supposition that at some period this muddy bottom was more extensive than at present; that the oyster bed was then formed, and was destroyed by the encroachment of the sand forming the Tryon Shoal."

"During the past ten or twelve years, *millions* of tons of oyster shells and mud have been taken up by our farmers, from oyster beds, by means of dredging machines, worked by horses on the ice. In many instances the beds have been cut through, and in some places the deposits of shells have been found to be upwards of twenty feet in thickness. It is probable that many of the oyster beds ceased to be productive of oysters, ages before the settlement of the country by Europeans. Extensive deposits of oyster shells are now found covered by several feet of silt. How were the oysters upon these beds destroyed? The natural process of reproduction and decay would cause the oyster beds formed on the bottom to rise so near to the surface of the water, that the ice would rest on them. The weight of heavy masses of ice upon the beds would injure the oysters, and the moving of the ice, when forced by tide or wind across the bed, would soon destroy them. I have observed the more elevated portions of an oyster bed, over which ice had been thus forced. Several inches of the surface of the bed, including all the living oysters, had been driven before the ice, and the shells and oysters so removed, had been deposited in a miniature *moraine* on the slope of the bed, where the water was sufficiently deep to allow the ice to pass over it. This crushing and grinding process would destroy many of the oysters; some would be crushed and broken, others smothered in the *moraine*. The gradual silting up of the river would prevent the running of the ice, and the oyster beds would, in time, be covered, as we now find them. Deposits of oyster shells (covered with mud), twenty feet in depth, are found in rivers, in the deepest parts of which there are not now fourteen feet of water."

"Oysters thrive on muddy bottoms, but they will not live if imbedded in mud: many oyster beds have been destroyed by mud alone. The annual fishing of oyster beds, if not carried to excess, improves them. In the process of fishing the surface of the bed is broken up, the shells and oysters lifted out of the mud, and a supply of material (cultch) afforded such as the oyster *spat* requires, and without which it must perish."

"Oysters upon natural beds are seldom, if ever, killed by frost. I have known oysters to thrive upon a hard stony bottom, notwithstanding that the ice rested upon them once in every twenty-four hours throughout the winter. Some of these oysters grew adherent to a small flat rock about eight inches in thickness. The oysters on the top of the rock were killed when they attained their second years' growth, I think, by pressure, as those on its edges were never injured by ice or cold."

"Oyster beds in rivers in which sawdust is thrown in large quantities would probably be injured by it. The sawdust would, I think, be carried by the current over the beds, and the roughness of their surface would detain some of it. The interstices between the shells and oysters would probably become filled with sawdust and mud. Mud and decomposing sawdust constitute a most offensive compound."

"The area of productive oyster beds in the Dominion is comparatively limited, and altogether inadequate to supply the demand for oysters which is now enormous, and which is increasing every year. Unless the existing beds be protected and improved, and new beds formed, the day will soon come when the oyster beds of the Dominion will cease to produce. Our neighbours of the United States tell us that Virginia alone possesses more than one-and-a-half millions of acres of oyster beds, and, notwithstanding the fact that oysters increase much more rapidly in the warmer waters of Virginia than they do in this latitude the authorities of that State have expressed their fears that the oyster beds of Virginia, if left open to the world, and dredged at all seasons of the year, will become extinct."

"The rivers and estuaries of this Island are admirably adapted for the cultivation of oysters. The oysters found in its bays are not to be excelled in flavour, and if fished late in autumn they will keep good for months. I see no reason why hundreds of thousands of acres of oysters beds should not be formed in these bays, which would produce vast quantities of oysters in quality much superior to the oysters of Virginia. The material for the formation of such beds is at hand in the ancient ones; and oysters with which to sow them could be had at little cost during the warm calm days of summer."

"We have a 'close season,' from June until September, but the law prohibiting fishing during this season is openly violated. Oysters are caught and exposed for sale in every month in the year, and salmon are destroyed upon their spawning beds with the utmost impunity. I shall be happy to hear that the Dominion Government have resolved to enforce the laws for the protection of oysters, salmon and trout. We now form part of the Dominion, as you know, and have a right to look for wiser legislation and a better administration of law."

"You inquire—'do you think oysters, would thrive in somewhat deeper water than that in which they are now found, if sown there?' I think they would thrive in the deepest part of any inland water, if placed upon suitable ground."

In another letter received later, Mr. Pope expresses the hope that the Minister of Marine and Fisheries will think proper to appoint a commission to report upon the oysters and oyster fisheries of the Island, and intimates that in such an event he would have no objection to give his services gratuitously.

The only oyster beds which we were able to examine at all in detail were those in Shediac bay. On these grounds, in very shallow water, the dredge came with the bag more or less full of oysters, or rather of oyster shells (for upwards of ninety per cent.

of the specimens were dead), together with some other common kinds of shells, &c., and a little blackish mud, which smelt very offensively. As there is a lumber mill in the bay, this ground is probably an example of the "offensive compound of mud and decomposing sawdust," of which Mr. Pope speaks. In a whole afternoon's dredging we only got two or three living oysters. Being detained a few days at Point du Chêne, I endeavoured to get some idea of the fauna of the bay, at depths of from low-water mark to three fathoms, particularly with the view of ascertaining what kinds of marine animals were associated with the oysters, and how many of them were injurious to that mollusc. The following is a list of the species collected in Shediac Bay; those which are supposed to be more or less inimical to the oyster being italicised:—

CRUSTACEA.
Cancer irroratus. *Say.*
Crangon vulgaris. *Fab:*
† Gammarus ornatus. *Edw.*
Idotea irrorata. *Say.*
MOLLUSCA.
Ostrea borealis. *Lam.*
O. Virginiana. *Lister.*
Mytilus edulis. *Linn.*
Modiola modiolus. *Linn.*
Mercenaria violacea. *Schum.*
Gemma Tottenii, *St.*
Callista convexa. *Say.*
Petricola pholadiformis. *Lam.*
and var. dactylus.
Mactra solidissima *Chemn.*
Mya arenaria.
" truncata.
Angulus tener. *Say.*
Thracia Conradi (fine & frequent.)
Pandora trilineata, *Say.*
Solen ensis, v. Americana.
Teredo, sp. (in a spruce log).
Haminea solitaria. *Say.*
Cylichna pertenuis. *Migh.*
Acmœa alveus. *Conrad.*
Crepidula fornicata. *Linn.*
" unguiformis. *Lam.*
Paludinella minuta.
Odostomia trifida. *Totten.*
Turbonilla interrupta. *Totten.*
Lunatia heros. *Say.*
Bittium nigrum. *Totten.*
Nassa obsoleta. *Say.*
" trivittata. *Say.*
Astyris lunata. *Say.*
ECHINODERMATA.
Asteria vulgaris *St.*
Cribella sanguinolenta.
Echinarachnius parma.
Echinus Dröbachiensis.
Caudina arenata (*Gould*)

In addition to these, algœ were tolerably plentiful, and a small number of annelids and zoophytes was collected. Of course the short catalogue given is by no means offered as a complete list of the fauna of the oyster beds. The chief living enemies of the oyster in its native waters are starfishes, sea eggs (Echinus), carnivorous sea snails or whelks (the "drills" of the European oystermen), and mussels. So far as I could see, these do not exist in sufficient abundance in Northumberland Straits to be of any serious disadvantage.

Many once productive beds, in various parts of the Gulf, now yield almost nothing; and there is too much reason to fear that unless precautionary measures are adopted, the oyster fisheries of the eastern part of the Dominion will soon become a thing of the past. The raking of the beds has been palpably excessive and wasteful; no such thing as cleansing the ground and scattering the spat during the close season has ever been practised; the pollution of the grounds by refuse of mills, by silting up, and a variety of other causes, has led to the present state of ruin and decay which we now see. Neglect, waste, and excessive cupidity have almost destroyed these oyster beds, and will ultimately entirely do so unless remedial measures are adopted.

THE CARNIVOROUS HABITS OF PLANTS.*

I have chosen for the subject of my address to you from the chair in which the Council of the British Association has done me the honour of placing me, the carnivorous habits of some of our brother-organisms—Plants.

Various observers have described with more or less accuracy the habits of such vegetable sportsmen as the Sundew, the Venus's Fly-trap, and the Pitcher-plants, but few have inquired into their motives; and the views of those who have most accurately appreciated these have not met with that general acceptance which they deserved.

Quite recently the subject has acquired a new interest, from the researches of Mr. Darwin into the phenomena which accompany the placing albuminous substances on the leaves of Drosera and Pinguicula, and which, in the opinion of a very eminent physiologist, prove, in the case of Dionæa, that this plant digests exactly the same substances and in exactly the same way that the human stomach does. With these researches Mr. Darwin is still actively engaged, and it has been with the view of rendering him such aid as my position and opportunities at Kew afforded me, that I have, under his instructions, examined some other carnivorous plants.

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* Address in the Department of Zoology and Botany, British Association, Belfast, August 21, by Dr. Hooker, C. B., D. C. L., Pres. R.S.

In the course of my inquiries I have been led to look into the early history of the whole subject, which I find to be so little known and so interesting that I have thought that a sketch of it, up to the date of Mr. Darwin's investigations, might prove acceptable to the members of this Association. In drawing it up, I have been obliged to limit myself to the most important plants; and with regard to such of these as Mr. Darwin has studied, I leave it to him to announce the discoveries which, with his usual frankness, he has communicated to me and to other friends; whilst with regard to those which I have myself studied, Sarracenia and Nepenthes, I shall briefly detail such of my observations and experiments as seem to be the most suggestive.

Dionæa.—About 1768 Ellis, a well-known English naturalist, sent to Linnæus a drawing of a plant, to which he gave the poetical name of Dionæa. "In the year 1765," he writes, "our late worthy friend, Mr. Peter Collinson, sent me a dried specimen of this curious plant, which he had received from Mr. John Bartram, of Philadelphia, botanist to the late King." Ellis flowered the plant in his chambers, having obtained living specimens from America. I will read the account which he gave of it to Linnæus, and which moved the great naturalist to declare that, though he had seen and examined no small number of plants, he had never met with so wonderful a phenomenon:—

"The plant, Ellis says, shows that Nature may have some views towards its nourishment, in forming the upper joint of its leaf like a machine to catch food; upon the middle of this lies the bait for the unhappy insect that becomes its prey. Many minute red glands that cover its surface, and which perhaps discharge sweet liquor, tempt the animal to taste them; and the instant these tender parts are irritated by its feet, the two lobes rise up, grasp it fast, lock the rows of spines together, and squeeze it to death. And further, lest the strong efforts for life in the creature just taken should serve to disengage it, three small erect spines are fixed near the middle of each lobe, among the glands, that effectually put an end to all its struggles. Nor do the lobes ever open again, while the dead animal continues there. But it is nevertheless certain that the plant cannot distinguish an animal from a vegetable or mineral substance; for if we introduce a straw or pin between the lobes, it will grasp it fully as fast as if it was an insect."

This account, which in its way is scarcely less horrible than the descriptions of those mediæval statues which opened to embrace and stab their victims, is substantially correct, but erroneous in some particulars. I prefer to trace out our knowledge of the facts in historical order, because it is extremely important to realise in so doing how much our appreciation of tolerably simple matters may be influenced by the prepossessions that occupy our mind.

We have a striking illustration of this in the statement published by Linnæus a few years afterwards. All the facts which I have detailed to you were in his possession; yet he was evidently unable to bring himself to believe that Nature intended the plant—to use Ellis's words—"to receive some nourishment from the animals it seizes;" and he accordingly declared, that as soon as the insects ceased to struggle, the leaf opened and let them go. He only saw in these wonderful actions an extreme case of sensitiveness in the leaves, which caused them to fold up when irritated, just as the sensitive plant does; and he consequently regarded the capture of the disturbing insect as something merely accidental and of no importance to the plant. He was, however, too sagacious to accept Ellis's sensational account of the *coup de grace* which the insects received from the three stiff hairs in the centre of each lobe of the leaf.

Linnæus's authority overbore criticism, if any were offered; and his statements about the behaviour of the leaves were faithfully copied from book to book.

Broussonet (in 1784) attempted to explain the contraction of the leaves by supposing that the captured insect pricked them, and so let out the fluid which previously kept them turgid and expanded.

Dr. Darwin (1761) was contented to suppose that the Dionæa surrounded itself with insect traps to prevent depredations upon its flowers.

Sixty years after Linnæus wrote, however, an able botanist, the Rev. Dr. Curtis (dead but a few years since) resided at Wilmington, in North Carolina, the head-quarters of this very local plant. In 1834 he published an account of it in the *Boston Journal of Natural History*, which is a model of accurate scientific observation. This is what he said:—"Each half of the leaf is a little concave on the inner side, where are placed three delicate hair-like organs, in such an order that an insect can hardly traverse it without interfering with one of them, when the two sides suddenly collapse and enclose the prey, with a force surpassing an insect's efforts to escape. The fringe of hairs on the opposite sides of a leaf interlace, like the fingers of two hands clasped together. The sensitiveness resides only in these hair-like processes on the inside, as the leaf may be touched or pressed in any other part without sensible effects. The little prisoner is not crushed and suddenly destroyed, as is sometimes supposed, for I have often liberated captive flies and spiders, which sped away as fast as fear or joy could carry them. At other times I have found them enveloped in a fluid of a mucilaginous consistence, which seems to act as a solvent, the insects being more or less consumed in it."

To Ellis belongs the credit of divining the purpose of the capture of insects by the Dionæa. But Curtis made out the details of the mechanism, by ascertaining the seat of the sensitiveness in the leaves; and he also pointed out that the secretion was not a lure exuded before the capture, but a true digestive fluid poured out, like our own gastric juice after the ingestion of food.

For another generation the history of this wonderful plant stood still; but in 1868 an American botanist, Mr. Canby, who is happily still engaged in botanical research—while staying in the Dionæa district, studied the habits of the plant pretty carefully, especially the points which Dr. Curtis had made out. His first idea was that "the leaf had the power of dissolving animal matter, which was then allowed to flow along the somewhat trough-like petiole to the root, thus furnishing the plant with highly nitrogenous food." By feeding the leaves with small pieces of beef, he found, however, that these were completely dissolved and absorbed; the leaf opening again with a dry surface, and ready for another meal, though with an appetite somewhat jaded. He found that cheese disagreed horribly with the leaves, turning them black, and finally killing them. Finally, he details the useless struggles of a Curculio to escape, as thoroughly establishing the fact that the fluid already mentioned is actually secreted, and is not the result of the decomposition of the substance which the leaf has seized. The Curculio being of a resolute nature, attempted to eat his way out,—"when discovered he was still alive, and had made a small hole through the side of the leaf, but was evidently becoming very weak. On opening the leaf, the fluid was found in considerable quantity around him, and was without doubt gradually overcoming him. The leaf being again allowed to close upon him. he soon died."

At the meeting of this Association last year, Dr. Burdon-Sanderson made a communication. which, from its remarkable character, was well worthy of the singular history of this plant; one by no means closed yet, but in which his observations will head a most interesting chapter.

It is a generalisation—now almost a household word—that all living things have a common bond of union in a substance—always present where life manifests itself—which underlies all their details of structure. This is called *protoplasm*. One of its most distinctive properties is its aptitude to contract; and when in any given organism the particles of protoplasm are so arranged that they act as it were in concert, they produce a cumulative effect which is very manifest in its results. Such a manifestation is found in the contraction of muscle; and such a manifestation we possibly have also in the contraction of the leaf of Dionæa.

The contraction of muscle is well known to be accompanied by certain electrical phenomena. When we place a fragment of muscle in connection with a delicate galvanometer, we find that between the outside surface and a cut surface there is a definite current, due to what is called the electromotive force of the muscle. Now, when the muscle is made to contract, this electromotive force momentarily disappears. The needle of the galvanometer, deflected before, swings back towards the point of rest; there is what is called a *negative variation.* All students of the vegetable side of organised nature were astonished to hear from Dr. Sanderson that certain experiments which, at the instigation of Mr. Darwin, he had made, proved to demonstration that when a leaf of Dionæa contracts, the effects produced are precisely similar to those which occur when muscle contracts.

Not merely, then, are the phenomena of digestion in this wonderful plant like those of animals, but the phenomena of contractility agree with those of animals also,

Drosera.—Not confined to a single district in the New World, but distributed over the temperate parts of both hemispheres, in sandy and marshy places, are the curious plants called Sundews—the species of the genus Drosera. They are now known to be near congeners of Dionæa, a fact which was little more than guessed at when the curious habits which I am about to describe were first discovered

Within a year of each other, two persons—one an Englishman, the other a German—observed that the curious hairs which everyone notices on the leaf of Drosera were sensitive.

This is the account which Mr. Gardom, a Derbyshire botanist, gives of what his friend Mr. Whateley, "an eminent London surgeon," made out in 1780:—"On inspecting some of the contracted leaves we observed a small insect or fly very closely imprisoned therein, which occasioned some astonishment as to how it happened to get into so confined a situation. Afterwards, on Mr. Whateley's centrically pressing with a pin other leaves yet in their natural and expanded form, we observed a remarkably sudden and elastic spring of the leaves, so as to become inverted upwards, and, as it were, encircling the pin, which evidently showed the method by which the fly came into its embarrassing situation."

This must have been an account given from memory, and represents the movement of the hairs as much more rapid than it really is.

In July of the preceding year (though the account was not published till two years afterwards), Roth, in Germany, had remarked in *Drosera rotundifolia* and *longifolia*, "that many leaves were folded together from the point towards the base, and that all the hairs were bent like a bow, but that there was no apparent change on the leaf-stalk." Upon opening these leaves, he says, "I found in each a dead insect; hence I imagined that this plant, which has some resemblance to the *Dionæa muscipula*, might also have a similar moving power."

"With a pair of pliers I placed an ant upon the middle of the leaf of *D. rotundifolia*, but not so as to disturb the plant. The ant endeavoured to escape, but was held fast by the clammy juice at the points of the hairs, which was drawn out by its feet into fine threads. In some minutes the short hairs on the disc of the leaf began to bend, then the long hairs, and laid themselves upon the insect. After a while the leaf began to bend, and in some hours the end of the leaf was so bent inwards as to touch the base. The ant died in fifteen minutes, which was before all the hairs had bent themselves."

These facts, established nearly a century ago by the testimony of independent observers, have up to the present time been almost ignored; and Trecul, writing in 1855, boldly asserted that the facts were not true.

More recently, however, they have been repeatedly verified: in Germany by Nilschke, in 1860; in America by a lady, Mrs. Treat, of New Jersey, in 1871; in this country by Mr. Darwin, and also by Mr. A. W. Bennett.

To Mr. Darwin, who for some years past has had the subject under investigation, we are indebted, not merely for the complete confirmation of the facts attested by the earliest observers, but also for some additions to those facts which are extremely important. The whole investigation still awaits publication at his hands, but some of the points which were established have been announced by Professor Asa Gray in America, to whom Mr. Darwin had communicated them.

Mr. Darwin found that the hairs on the leaf of Drosera responded to a piece of muscle or other animal substance, while to any particle of inorganic matter they were nearly indifferent. To minute fragments of carbonate of ammonia they were more responsive.

I will now give the results of Mrs. Treat's experiments, in her own words:—

"Fifteen minutes past ten I placed bits of raw beef on some of the most vigorous leaves of *Drosera longifolia*. Ten minutes past twelve two of the leaves had folded around the beef, hiding it from sight. Half-past eleven on the same day, I placed living flies on the leaves of *D. longifolia*. At twelve o'clock and forty-eight minutes, one of the leaves had folded entirely round its victim, and the other leaves had partially folded, and the flies had ceased to struggle. By half-past two, four leaves had each folded around a fly. The leaf folds from the apex to the petiole, after the manner of its vernation. I tried mineral substances, bits of dried chalk, magnesia, and pebbles. In twenty-four hours neither the leaves nor the bristles had made any move in clasping these articles. I wetted a piece of chalk in water, and in less than an hour the bristles were curving about it, but soon unfolded again, leaving the chalk free on the blade of the leaf."

Time will not allow me to enter into further details with respect to Dionæa and Drosera. The repeated testimony of various observers spreads over a century, and though at no time warmly received, must, I think, satisfy you that in this smal family of the Droseraceæ we have plants which in the first plac capture animals for purposes of food, and in the second, dige and dissolve them by means a fluid which is poured out the purpose; and thirdly, absorb the solution of animal matter which is so produced.

Before the investigations of Mr. Darwin had led other persons to work at the subject, the meaning of these phenomena was very little appreciated. Only a few years ago, Duchartre, a French physiological botanist, after mentioning the views of Ellis and Curtis with respect to Dionæa, expressed his opinion that the idea that its leaves absorbed dissolved animal substances was too evidently in disagreement with our knowledge of the function of leaves and the whole course of vegetable nutrition to deserve being seriously discussed.

Perhaps if the Droseraceæ were an isolated case of a group of plants exhibiting propensities of this kind, there might be some reason for such a criticism. But I think I shall be able to show you that this is by no means the case. We have now reason to believe that there are many instances of these carniovrous habits in different parts of the vegetable kingdom, and among plants which have nothing else in common but this.

As another illustration I shall take the very curious group of Pitcher-plants which is peculiar to the New World. And here also I think we shall find it most convenient to follow the historical order in the facts.

Sarracenia.—The Genus Sarracenia consists of eight species, all similar in habit, and all natives of the Eastern States of North America, where they are found more especially in bogs, and even in places covered with shallow water. Their leaves, which give them a character entirely their own, are pitcher-shaped or trumpet-like, and are collected in tufts springing immediately from the ground; and they send up at the flowering season one or more slender stems bearing each a solitary flower. This has a singular aspect, due to a great extent to the umbrella-like expansion in which the style terminates; the shape of this, or perhaps, of the whole flower, caused the first English settlers to give to the plant the name of Side-saddle Flower.

Sarracenia purpurea is the best known species. About ten years ago it enjoyed an evanescent notoriety from the fact that its rootstock was proposed as a remedy for small-pox. It is found from Newfoundland southward to Florida, and is fairly hardy under open-air cultivation in the British Isles. At the commencement of the seventeenth century, Clusius published a figure of it, from a sketch which found its way to Lisbon and thence to Paris. Thirty years later Johnson copied this in his edition of Gerard's Herbal, hoping "that some or other that travel into foreign parts may find this elegant plant, and know it by this small expression, and bring it home with them, so that we may come to a perfecter knowledge thereof." A few years afterwards this wish was gratified. John Tradescant the younger found the plant in Virginia, and succeeded in bringing it home alive to England. It was also sent to Paris from Quebec by Dr. Sarrazin, whose memory has been commemorated in the name of the genus, by Tournefort.

The first fact which was observed about the pitchers was, that when they grew they contained water. But the next fact which was recorded about them was curiously mythical. Perhaps Morrison, who is responsible for it, had no favourable opportunites of studying them, for he declares them to be what is by no means really the case, intolerant of cultivation (*respuere culturam videntur*).

He speaks of the lid, which in all the species is tolerably rigidly fixed, as being furnished, by a special act of providence, with a hinge. This idea was adopted by Linnæus, and somewhat amplified by succeeding writers, who declared that in dry weather the lid closed over the mouth, and checked the loss of water by evaporation. Catesby, in his fine work on the Natural History of Carolina, supposed that these water-receptacles might "serve as an asylum or secure retreat for numerous insects, from frogs and other animals which feed on them;"—and others followed Linnæus in regarding the pitchers as reservoirs for birds and other animals, more especially in times of drought; "*præbet aquam sitientibus aviculis.*"

The superficial teleology of the last century was easily satisfied without looking far for explanations, but it is just worth while pausing for a moment to observe that, although Linnæus had no materials for making any real investigation as to the purpose of the pitchers of Sarracenias, he very sagaciously anticipated the modern views as to their affinities. They are now regarded as very near allies of water-lilies—precisely the position which Linnæus assigned to them in his fragmentary attempt at a true natural classification. And besides this, he also suggested the analogy, which, improbable as it may seem at first sight, has been worked out in detail by Baillon (in apparent ignorance of Linnæus' writings) between the leaves of Sarracenia and water-lilies.

Linnæus seems to have supposed that Sarracenia was originally aquatic in its habits, that it had Nymphæa-like leaves, and that when it took to a terrestrial life its leaves became hollowed out, to contain the water in which they could no longer float —in fact, he showed himself to be an evolutionist of the true Darwinian type.

Catesby's suggestion was a very infelicitous one. The insects which visit these plants may find in them a retreat, but it is one from which they never return. Linnæus' correspondent Collinson, remarked in one of his letters, that "many poor insects lose their lives by being drowned in these cisterns of water;" but William Bartram, the son of the botanist, seems to have been the first to put on record, at the end of the last century, the fact that Sarracenias catch insects and put them to death in the wholesale way that they do.

Before stopping to consider how this is actually achieved, I will carry the history a little further.

In the two species in which the mouth is unprotected by the lid it could not be doubted that a part, at any rate, of the contained fluid was supplied by rain. But in *Sarracenia variolaris*, in which the lid closes over the mouth, so that rain cannot readily enter it, there is no doubt that a fluid is secreted at the bottom of the pitchers, which probably has a digestive function. William Bartram, in the preface to his travels in 1791, described this fluid, but he was mistaken in supposing that it acted as a lure. There is a sugary secretion which attracts insects, but this is only found at the upper part of the tube. Bartram must be credited with the suggestion, which he, however, only put forward doubtfully, that the insects were dissolved in the fluid, and then became available for the alimentation of the plants.

Sir J. E. Smith, who published a figure and description of *Sarracenia variolaris*, noticed that it secreted fluid, but was content to suppose that it was merely the gaseous products of the decomposition of insects that subserved the processes of vegetation. In 1829, however, thirty years after Bartram's book, Burnett wrote a paper containing a good many original ideas expressed in a somewhat quaint fashion, in which he very strongly insisted on the existence of a true digestive process in the case of Sarracenia, analogous to that which takes place in the stomach of an animal.

Our knowledge of the habits of *Sarracenia variolaris* is now pretty complete, owing to the observations of two South Carolina physicians. One, Dr. M'Bride, made his observations half a century ago, but they had, till quite recently, completely fallen into oblivion. He devoted himself to the task of ascertaining why it was that *Sarracenia variolaris* was visited by flies, and how it was that it captured them. This is what he ascertained: "The cause which attracts flies is evidently a viscid substance resembling honey, secreted by or exuding from the internal surface of the tube. From the margin, where it commences, it does not extend lower than one-fourth of an inch. The falling of the insect as soon as it enters the tube is wholly attributable to the downward or inverted position of the hairs of the internal surface of the leaf. At the bottom of a tube split open, the hairs are plainly discernible, pointing downwards; as the eye ranges upward they gradually become shorter and attenuated, till at or just below the surface covered by the bait they are no longer perceptible to the naked eye, nor to the most delicate touch. It is here that the fly cannot take a hold sufficiently strong to support itself, but falls."

Dr. Mellichamp, who is now resident in the district in which Dr. M'Bride made his observations, has added a good many particulars to our knowledge. He first investigated the fluid which is secreted at the bottom of the tubes. He satisfied himself that it was really secreted, and describes it as mucilaginous, but leaving in the mouth a peculiar astringency. He compared the action of this fluid with that of distilled water on pieces of fresh venison, and found that after fifteen hours the fluid had produced most change, and also most smell; he therefore concluded that as the leaves when stuffed with insects become most disgusting in odour, we have to do, not with a true digestion, but with an accelerated decomposition. Although he did not attribute any true digestive power to the fluid secreted by the pitchers, he found that it had a remarkable anæsthetic effect on flies immersed in it. He remarked that "a fly when thrown into water is very apt to escape, as the fluid seems to *run* from its wings," but it never escaped from the Sarracenia secretion. About half a minute after being thrown in, the fly became to all appearance dead, though, if removed, it gradually recovered in from half an hour to an hour.

According to Dr. Mellichamp, the sugary lure discovered by Dr. M'Bride, at the mouth of the pitchers, is not found on either the young ones of one season or the older ones of the previous year. He found, however, that about May it could be detected without difficulty, and more wonderful still, that there is a honeybaited pathway leading directly from the ground to the mouth, along the broad wing of the pitcher, up which insects are led to their destruction. From these narratives it is evident that there are two very different types of pitcher in Sarracenia, and an examination of the species shows that there may probably be three. These may be primarily classified into those with the mouth open and lid erect, and which consequently receive the rain-water in more or less abundance; and those with the mouth closed by the lid, into which rain can hardly, if at all, find ingress.

To the first of these belongs the well-known *S. purpurea*, with inclined pitchers, and a lid so disposed as to direct all the rain that falls upon it also into the pitcher; also *S. flava*, *rubra*, and *Drummondii*, all with erect pitchers and vertical lids; of these three, the lid in a young state arches over the mouth, and in an old state stands nearly erect, and has the sides so reflected that the rain which falls on its upper surface is guided down the outside of the back of the pitcher, as if to prevent the flooding of the latter.

To the second group belong *S. psittacina* and *S. variolaris*.

The tissues of the internal surfaces of the pitchers are singularly beautiful. They have been described in one species only, the *S. purpurea*, by August Vogl; but from this all the other species which I have examined differ materially. Beginning from the upper part of the pitcher, there are four surfaces, characterised by different tissues, which I shall name and define as follows:—

1. An *attractive* surface, occupying the inner surface of the lid, which is covered with an epidermis, stomata, and (in common with the mouth of the pitcher) with minute honey-secreting glands; it is further often more highly coloured than any other part of the pitcher, in order to attract insects to the honey.

2. A *conducting* surface, which is opaque, formed of glassy cells, which are produced into deflexed, short, conical, spinous processes. These processes, overlapping like the tiles of a house, form a surface down which an insect slips, and affords no foothold to an insect attempting to crawl up again.

3. A *glandular* surface (seen in *S. purpurea*), which occupies a considerable portion of the cavity of the pitcher below the conducting surface. It is formed of a layer of epidermis with sinuous cells, and is studded with glands; and being smooth and polished, this too affords no foothold for escaping insects.

4. A *detentive* surface, which occupies the lower part of the pitcher, in some cases for nearly its whole length. It possesses no cuticle, and is studded with deflexed, rigid, glass-like, needle-formed, striated hairs, which further converge towards the axis of the diminishing cavity; so that an insect, if once amongst them, is effectually detained, and its struggles have no other result than to wedge it lower and more firmly in the pitcher.

Now, it is a very curious thing that in *S. purpurea*, which has an open pitcher, so formed as to receive and retain a maximum of rain, no honey-secretion has hitherto been found, nor has any water been seen to be secreted in the pitcher; it is, further, the only species in which (as stated above) I have found a special glandular surface, and in which no glands occur on the detentive surface. This concurrence of circumstances suggests the possibility of this plant either having no proper secretion of its own, or only giving it off after the pitcher has been filled with rain-water.

In *S. flava*, which has open-mouthed pitchers and no special glandular surface, I find glands in the upper portion of the detentive surface, among the hairs, but not in the middle or lower part of the same surface. It is proved that *S. flava* secretes fluid, but under what precise conditions I am not aware. I have found none but what may have been accidentally introduced in the few cultivated specimens which I have examined, either in the full-grown state, or in the half-grown when the lid arches over the pitcher. I find the honey in these as described by the American observers, and honey-secreting glands on the edge of the wing of the pitcher, together with similar glands on the outer surface of the pitcher, as seen by Vogl in *S. purpurea*.

Of the pitchers with closed mouths, I have examined those of *S. variolaris* only, whose tissues closely resemble those of *S. flava*. That it secrets a fluid noxious to insects there is no doubt, though in the specimens I examined I found none.

There is thus obviously much still to be learned with regard to Sarracenia, and I hope that American botanists will apply themselves to this task. It is not probable that three pitchers, so differently constructed as those of *S. flava*, *purpurea*, and *variolaris*, and presenting such differences in their tissues, should act similarly. The fact that insects normally decompose in the fluid of all, would suggest the probability that they all feed on the products of decomposition; but as yet we are absolutely ignorant whether the glands within the pitchers are secretive, or absorptive, or both; if secretive, whether they secrete water or a solvent; and if absorptive, whether they absorb animal matter or the products of decomposition.

It is quite likely, that just as the saccharine exudation only makes its appearance during one particular period in the life of the pitcher, so the digestive functions may also be only of short duration. We should be prepared for this from the case of the Dionæa, the leaves of which cease after a time to be fit for absorption, and become less sensitive. It is quite certain that the insects which go on accumulating in the pitchers of Sarracenias must be far in excess of its needs for any legitimate process of digestion. They decompose; and various insects, too wary to be entrapped themselves, seem habitually to drop their eggs into the open mouth of the pitchers, to take advantage of the accumulation of food. The old pitchers are consequently found to contain living larvæ and maggots, a sufficient proof that the original properties of the fluid which they secreted must have become exhausted; and Barton tells us that various insectivorous birds slit open the pitchers with their beaks to get at the contents. This was probably the origin of Linnæus' statement that the pitchers supplied birds with water.

The pitchers finally decay, and part, at any rate, of their contents must supply some nutriment to the plant by fertilising the ground in which it grows.

Darlingtonia.—I cannot take leave of Sarracenia without a short notice of its near ally, Darlingtonia, a still more wonderful plant, an outlier of Sarracenia in geographical distribution, being found at an elevation of 5,000 ft. on the Sierra Nevada of California, far west of any locality inhabited by Sarracenia. It has pitchers of two forms; one, peculiar to the infant state of the plant, consists of narrow, somewhat twisted, trumpet-shaped tubes, with very oblique open mouths, the dorsal lip of which is drawn out into a long, slender, arching, scarlet hood, that hardly closes the mouth. The slight twist in the tube causes these mouths to point in various directions, and they entrap very small insects only. Before arriving at a state of maturity the plant bears much larger, suberect pitchers, also twisted, with the lip produced into a large inflated hood, that completely arches over a very small entrance to the cavity of the pitchers. A singular orange-red, flabby, two-lobed organ hangs from the end of the hood, right in front of the entrance, which, as I was informed last week by letter from Prof. Asa Gray, is smeared with honey on its inner surface. These pitchers are crammed with large insects, especially moths, which decompose in them, and result in a putrid mass. I have no information of water being found in its pitchers in its native country, but have myself found a slight acid secretion in the young states of both forms of pitcher.

The tissues of the inner surfaces of the pitchers of both the young and the old plant I find to be very similar to those of *Sarracenia variolaris* and *flava*.

Looking at a flowering specimen of Darlingtonia, I was struck with a remarkable analogy between the arrangement and colouring of the parts of the leaf and of the flower. The petals are of the same colour as the flap of the pitcher, and between each pair of petals is a hole (formed by a notch in the opposed margins of each) leading to the stamens and stigma. Turning to the pitcher, the relation of its flap to its entrance is somewhat similar. Now, we know that coloured petals are specially attractive organs, and that the object of their colour is to bring insects to feed on the pollen or nectar, and in this case by means of the hole to fertilise the flower; and that the object of the flap and its sugar is also to attract insects, but with a very different result, cannot be doubted. It is hence conceivable that this marvellous plant lures insects to its flowers for one object, and feeds them while it uses them to fertilise itself, and that, this accomplished, some of its benefactors are thereafter lured to its pitchers for the sake of feeding itself!

But to return from mere conjecture to scientific earnest, I cannot dismiss Darlingtonia without pointing out to you what appears to me a most curious point in its history; which is, that the change from the slender, tubular, open-mouthed to the inflated closed-mouthed pitchers, is, in all the specimens which I have examined, absolutely sudden in the individual plant. I find no pitchers in an intermediate stage of development. This, a matter of no little significance in itself, derives additional interest from the fact that the young pitchers to a certain degree represent those of the Sarracenias with open mouths and erect lids; and the old pitchers those of the Sarracenias with closed mouths and globose lids. The combination of representative characters in an outlying species of a small order cannot but be regarded as a marvellously significant fact in the view of those morphologists who hold the doctrine of evolution.

Nepenthes.—The genus Nepenthes consists of upwards of thirty species of climbing, half shrubby plants, natives of the hotter parts of the Asiatic Archipelago from Borneo to Ceylon, with a few outlying species in New Caledonia, in Tropical Australia, and in the Seychelle Islands on the African coast. Its pitchers are abundantly produced, especially during the younger state of the plants. They present very considerable modifications of form and external structure, and vary greatly in size, from little more than an inch to almost a foot in length; one species, indeed, which I have here from the mountains of Borneo, has pitchers which, including the lid, measure a foot and a half, and its capacious bowl is large enough to drown a small animal or bird.

The structure of the pitcher of Nepenthes is less complicated on the whole than that of Sarracenia, though some of its tissues are much more highly specialised. The pitcher itself is here not a transformed leaf, as in Sarracenia, nor is it a transformed leaf-blade, like that of Dionæa, but an appendage of the leaf developed at its tip, and answers to a water-secreting gland that may be seen terminating the mid-rib of the leaf of certain plants. It is furnished with a stalk, often a very long one, which in the case of pitchers formed on leaves high up the stem has (before the full development of the pitcher) the power of twisting like a tendril round neighbouring objects, and thus aiding the plant in climbing, often to a great height in the forest.

In most species the pitchers are of two forms, one appertaining to the young, the other to the old state of the plant, the transition from one form to the other being gradual. Those of the young state are shorter and more inflated; they have broad fringed longitudinal wings on the outside, which are probably guides to lead insects to the mouth; the lid is smaller and more open, and the whole interior surface is covered with secreting glands. Being formed near the root of the plant, these pitchers often rest on the ground, and in species which do not form leaves near the root they are sometimes suspended from stalks which may be fully a yard long, and which bring them to the ground. In the older state of the plant the pitchers are usually much longer, narrower, and less inflated, and are trumpet-shaped, or even conical; the wings also are narrower, less fringed, or almost absent. The lid is larger and slants over the mouth, and only the lower part of the pitcher is covered with secreting glands, the upper part presenting a tissue analogous to the conducting tissue of Sarracenia, but very different anatomically. The difference in structure of these two forms of pitcher, if considered in reference to their different positions on the plant, forces the conclusion on the mind that the one form is intended for ground game, the other for winged game. In all cases the mouth of the pitcher is furnished with a thickened corrugated rim, which serves three purposes: strengthens the mouth and keeps it distended; it secretes honey (at least in all the species I have examined under cultivation, for I do not find that any other observer has noticed the secretion of honey by Nepenthes), and it is in various species developed into a funnel-shaped tube that descends into the pitcher and prevents the escape of insects, or into a row of incurved hooks that are in some cases strong enough to retain a small bird, should it, when in search of water or insects, thrust its body beyond a certain length into the pitcher.

In the interior of the pitcher of Nepenthes there are three principal surfaces: an *attractive*, *conductive*, and a *secretive* surface; the *detentive* surface of Sarracenia being represented by the fluid secretion, which is here invariably present at all stages of growth of the pitcher.

The attractive surfaces of Nepenthes are two: those, namely, of the rim of the pitcher, and of the under surface of the lid, which is provided in almost every species with honey secreting glands, often in great abundance. These glands consist of spherical masses of cells, each embedded in a cavity of the tissue of the lid, and encircled by a guard-ring of glass-like cellular tissue. As in Sarracenia, the lid and mouth of the pitcher are more highly coloured than any other part, with the view of attracting insects to their honey. It is a singular fact that the only species known to me that wants these honey-glands on the lid is the *N. ampullaria*, whose lid, unlike that of the other species, is thrown back horizontally. The secretion of honey on a lid so placed would tend to lure insects away from the pitcher instead of into it.

From the mouth to a variable distance down the pitcher is an opaque glaucous surface, precisely resembling in colour and appearance the conductive surface of the Sarracenia, and, like it, affording no foothold to insects, but otherwise wholly different; it is formed of a fine network of cells, covered with a glass-like cuticle, and studded with minute reniform transverse excrescences.

The rest of the pitcher is entirely occupied with the secretive surface, which consists of a cellular floor crowded with spherical glands in inconceivable numbers. Each gland precisely resembles a honey-gland of the lid, and is contained in a pocket of the same nature, but semicircular, with the mouth downwards, so that the secretive fluid all falls to the bottom of the pitcher. In the *Nepenthes Rafflesiana* 3,000 of the glands occur on a square inch of the inner surface of the pitcher, and upwards of 1,000,000 in an ordinary sized pitcher. I have ascertained that, as was indeed to be expected, they secrete the fluid which is contained in the bottom of the pitcher before this opens, and that the fluid is always acid.

The fluid, though invariably present, occupies a comparatively small portion of the glandular surface of the pitcher, and is collected before the lid opens. When the fluid is emptied out of a fully formed pitcher that has not received animal matter, it forms again, but in comparatively very small quantities; and the formation goes on for many days, and to some extent even after the pitcher has been removed from the plant. I do not find that placing inorganic substances in the fluid causes an increased secretion, but I have twice observed a considerable increase of fluid in pitchers after putting animal matter in the fluid.

To test the digestive powers of Nepenthes I have closely followed Mr. Darwin's treatment of Dionæa and Drosera, employing white of egg, raw meat, fibrine, and cartilage. In all cases the action is most evident, in some surprising. After twenty-four hours' immersion the edges of the cubes of white of egg are eaten away and the surfaces gelatinised. Fragments of meat are rapidly reduced; and pieces of fibrine weighing several grains dissolve and totally disappear in two or three days. With cartilage the action is most remarkable of all; lumps of this weighing 8 or 10 grains are half gelatinized in twenty-four hours, and in three days the whole mass is greatly diminished, and reduced to a clear transparent jelly. After drying some cartilage in the open air for a week, and placing it in an unopened but fully formed pitcher of *N. Rafflesiana*, it was acted upon similarly and very little slower.

That this process, which is comparable to digestion, is not wholly due to the fluid first secreted by the glands, appears to me most probable; for I find that very little action takes place in any of the substances placed in the fluid drawn from pitchers, and put in glass tubes; nor has any followed after six days' immersion of cartilage or fibrine in pitchers of *N. ampullaria* placed in a cold room; whilst on transferring the cartilage from the pitcher of *N. ampullaria* in the cold room to one of *Rafflesiana* in the stove, it was immediately acted upon. Comparing the action of fibrine, meat, and cartilage placed in tubes of Nepenthes fluid, with others in tubes of distilled water, I observed that their disintegration is three times more rapid in the fluid; but this disintegration is wholly different from that effected by immersion in the fluid of the pitcher of a living plant.

In the case of small portions of meat, ½ to 2 grains, all seem to be absorbed; but with 8 to 10 grains of cartiage it is not so —a certain portion disappears, the rest remains as a transparent jelly, and finally becomes putrid, but not till after many days. Insects appear to be acted upon somewhat differently, for after several days' immersion of a large piece of cartilage I found that a good-sized cockroach, which had followed the cartilage and was drowned for his temerity, in two days became putrid. In removing the cockroach the cartilage remained inodorous for many days. In this case no doubt the antiseptic fluid had permeated the tissue of the cartilage, whilst enough did not remain to penetrate the chitinous hard covering of the insect, which consequently decomposed.

In the case of cartilage placed in fluid taken from the pitcher —it becomes putrid, but not so soon as if placed in distilled water.

From the above observations it would appear probable that a substance acting as pepsine is given off from the inner wall of the pitcher, but chiefly after placing animal matter in the acid fluid; but whether this active agent flows from the glands or from the cellular tissue in which they are imbedded, I have no evidence to show.

I have here not alluded to the action of these animal matters in the cells of the glands, which is, as has been observed by Mr.

Darwin in Drosera, to bring about remarkable changes in their protoplasm, ending in their discoloration. Not only is there aggregation of the protoplasm in the gland cells, but the walls of the cells themselves become discoloured, and the glandular surface of the pitcher that at first was of a uniform green, becomes covered with innumerable brown specks (which are the discoloured glands). After the function of the glands is exhausted, the fluid evaporates, and the pitcher slowly withers.

At this stage I am obliged to leave this interesting investigation. That Nepenthes possesses a true digestive process such as has been proved in the case of Drosera, Dionæa, and Pinguicula, cannot be doubted. This process, however, takes place in a fluid which deprives us of the power of following it further by direct observation. We cannot here witness the pouring out of the digestive fluid; we must assume its presence and nature from the behaviour of the animal matter placed in the fluid in the pitcher. From certain characters of the cellular tissues of the interior walls of the pitcher, I am disposed to think that it takes little part in the processes of either digestion or assimilation, and that these, as well as the pouring out of the acid fluid, are all functions of the glands.

In what I have said I have described the most striking instances of plants which seem to invert the order of nature, and to draw their nutriment—in part, at least—from the animal kingdom, which it is often held to be the function of the vegetable kingdom to sustain.

I might have added some additional cases to those I have already dwelt upon. Probably, too, there are others still unknown to science, or whose habits have not yet been detected. Delpino, for example, has suggested that a plant, first described by myself in the Botany of the Antartic Voyage, *Caltha dionæafolia*, is so analagous in the structure of its leaves to Dionæa, that it is difficult to resist the conviction that its stucture also is adapted for the capture of small insects.

But the problem that forces itself upon our attention is, How does it come to pass that these singular aberrations from the otherwise uniform order of vegetable nutrition make their appearance in remote parts of the vegetable kingdom? why are they not more frequent, and how were such extraordinary habits brought about or contracted? At first sight the perplexity is not diminished by considering—as we may do for a moment—

the nature of ordinary vegetable nutrition. Vegetation, as we see it everywhere, is distinguished by its green colour, which we know depends on a peculiar substance called chlorophyll, a substance which has the singular property of attracting to itself the carbonic acid gas which is present in minute quantities in the atmosphere, of partly decomposing it, so far as to set free a portion of its oxygen, and of recombining it with the elements of water, to form those substances, such as starch, cellulose, and sugar, out of which the framework of the plant is constructed.

But, besides these processes, the roots take up certain matters from the soil. Nitrogen forms nearly four-fifths of the air we breathe, yet plants can possess themselves of none of it in the free uncombined state. They withdraw nitrates and salts of ammonia in minute quantities from the ground, and from these they build up with starch, or some analogous material, albuminoids or protein compounds, necessary for the sustentation and growth of protoplasm.

At first sight nothing can be more unlike this than a Dionæa or a Nepenthes capturing insects, pouring out a digestive fluid upon them, and absorbing the albuminoids of the animal, in a form probably directly capable of appropriation for their own nutrition. Yet there is something not altogether wanting in analogy in the case of the most regularly constituted plants. The seed of the castor-oil plant contains, besides the embryo seedling, a mass of cellular tissue or endosperm filled with highly nutritive substances. The seedling lies between masses of this, and is in contact with it; and as the warmth and moisture of germination set up changes which bring about the liquefaction of the contents of the endosperm and the embryo absorbs them, it grows in so doing, and at last, having taken up all it can from the exhausted endosperm, develops chlorophyll in its cotyledons under the influence of light, and relies on its own resources.

A large number of plants, then, in their young condition, borrow their nutritive compounds ready prepared; and this is in effect what carnivorous plants do later in life.

That this is not a merely fanciful way of regarding the relation of the embryo to the endosperm, is proved by the ingenious experiments of Van Tieghem, who has succeeded in substituting for the real, an artificial endosperm, consisting of appropriate nutritive matters. Except that the embryo has its food given to it in a manner which needs no digestion—a proper concession to its infantine state—the analogy here with the mature plants which feed on organic food seems to be complete.

But we are beginning also to recognise the fact that there are a large number of flowering plants that pass through their lives without ever doing a stroke of the work that green plants do. These have been called Saprophytes. Monotropa, the curious bird's nest orchis (*Neottia nidus-avis*), Epipogium, and Corallorhiza are instances of British plants which nourish themselves by absorbing the partially decomposed materials of other plants, in the shady or marshy places which they inhabit. They reconstitute these products of organic decomposition, and build them up once more into an organism. It is curious to notice, however, that the tissues of Neottia still contain chlorophyll in a nascent though useless state, and that if a plant of it be immersed in boiling water, the characteristic green colour reveals itself.

Epipogium and Corallorhiza have lost their proper absorbent organs; they are destitute of roots, and take in their food by the surfaces of their underground stem structures.

The absolute difference between plants which absorb and nourish themselves by the products of the decomposition of plant-structures, and those which make a similar use of animal structures, is not very great. We may imagine that plants accidentally permitted the accumulation of insects in some parts of their structure, and the practice became developed because it was found to be useful. It was long ago suggested that the receptacle formed by the connate leaves of Dipsacus might be an incipient organ of this kind; and though no insectivorous habit has ever been brought home to that plant, the theory is not improbable.

Linnæus, and more lately Baillon, have shown how a pitcher of Sarracenia may be regarded as a modification of a leaf of the Nymphæa type. We may imagine such a leaf first becoming hollow, and allowing *débris* of different kinds to accumulate; these would decompose, and a solution would be produced, some of the constituents of which would diffuse themselves into the subjacent plant tissues. This is in point of fact absorption, and we may suppose that in the first instance—as perhaps still in *Sarracenia purpurea*—the matter absorbed was merely the saline nutritive products of decomposition, such as ammoniacal salts. The act of digestion—that process by which soluble food is reduced without decomposition to a soluble form fitted for absorption—was doubtless subsequently acquired.

The secretion, however, of fluids by plants is not an unusual phenomenon. In many Aroids a small gland at the apex of the leaves secretes fluid, often in considerable quantities, and the pitcher of Nepenthes is, as I have shown elsewhere, only a gland of this kind, enormously developed. May not, therefore, the wonderful pitchers and carnivorous habit of Nepenthes have both originated by natural selection out of one such honey-secreting gland as we still find developed near that part of the pitcher which represents the tip of the leaf? We may suppose insects to have been entangled in the viscid secretion of such a gland, and to have perished there, being acted upon by those acid secretions that abound in these and most other plants. The subsequent differentiation of the secreting organs of the pitcher into aqueous, saccharine, and acid, would follow *pari passu* with the evolution of the pitcher itself, according to those mysterious laws which result in the correlation of organs and functions throughout the kingdom of Nature; and which, in my apprehension, transcend in wonder and interest those of evolution and the origin of species.

Delpino has recorded the fact that the spathe of Alocasia secretes an acid fluid which destroys the slugs that visit it, and which he believes subserves its fertilisation. Here any process of nutrition can only be purely secondary. But the fluids of plants are in the great majority of cases acid, and, when exuded, would be almost certain to bring about some solution in substances with which they came in contact. Thus the acid secretions of roots were found by Sachs to corrode polished marble surfaces with which they came in contact, and thus to favour the absorption of mineral matter.

The solution of albuminoid substances requires, however, besides a suitable acid, the presence of some other albuminoid substance analogous to pepsine. Such substances, however, are frequent in plants. Besides the well-known diastase, which converts the starch of malt into sugar, there are other instances in the synaptase which determines the formation of hydrocyanic acid from emulsine, and the myrosin which similarly induces the formation of oil of mustard. We need not wonder, then, if the fluid secreted by a plant should prove to possess the ingredients necessary for the digestion of insoluble animal matters.

These remarks will, I hope, lead you to see, that though the processes of plant nutrition are in general extremely different from those of animal nutrition, and involve very simple compounds, yet that the protoplasm of plants is not absolutely prohibited from availing itself of food, such as that by which the protoplasm of animals is nourished; under which point of view these phenomena of carnivorous plants will find their place, as one more link in the continuity of nature.

NOTE ON CARNIVOROUS PLANTS.—Mr. Andrew Murray writes to the *Gardener's Chronicle* that he has, within the last few weeks, made some observations at the Ochil Hills, Kinross-shire, on *Pinguicula* and *Drosera*, with reference to the fly-digesting powers they are asserted to possess. He states that he found the leaves of *Pinguicula* close, quite independently of a fly being in them or not. "The leaves are found with their margins in all stages of curling over, some with no insect on them much more curled over than others with several." The secretion which Dr. Hooker states kills a captured insect, he finds is glutinous, and he believes it does not fall on to the insect, but that death results from the secretion adhering to and closing up the spiracles by which the insect breathes. With regard to *Dionœa* he suggests that it shonld be carefully noted (1) whether the secretion is never present until after an insect has been captured; (2) whether it is always present after one has.—*Nature.*

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THE THEORY OF ATOMS IN THE GENERAL CONCEPTION OF THE UNIVERSE.

Opening Address by the President, M. WURTZ, *at the Meeting of the French Association.*

Francis Bacon conceived the idea of a society of men devoted to the culture of science. In his "New Atlantis," in which he describes the organisation of this society and its influence upon the destinies of a wisely governed people, he shows it rising to the dignity of a State institution. The progress of civilisation by the search for truth, and truth discovered in the order of nature by experiment and observation—such are the ends proposed and the means made use of. Thus, in an age when the syllogism was still supreme, and which was firmly held beneath the scholastic yoke, the English Chancellor assigned to science at once its true method and its mission in the world.

The plan of Bacon embraced all branches of human knowledge. The land was overrun by a multitude of observers, engaged, some in studying the monuments of the past, the language, the manners, the history of the nations; others in observing the configuration and the productions of the soil, noting the superficial structure of the globe and the traces of its revolutions, collecting all the data concerning nature, the organisation and distribution of plants and animals. Other men, located in various regions, cultivated the exact sciences. Towers were constructed for the observation of stars and meteors; vast edifices, arranged for the study of physical and mechanical laws, contained machines which supplied the deficiency of our forces, and instruments which added to the precision of the senses and rendered abstract demonstrations sensible. This immense labour was uninterrupted, co-ordinated, controlled; it had its origin in self-abnegation, it was regulated by precision, and had time for its sanction. Thus was it fruitful.

Such was the idea of Francis Bacon. To observe all things; by the rational comparison of these observations to disclose the hidden connections of phenomena, and to rise by induction to the discovery of their real nature and their causes, all with the view "of extending the empire of man over entire nature, and of executing everything possible for him to do;" such is the object which he has pointed out to us; such is the function of science.

This great exploration of the earth which he desired to institute, this patient and exact research of the laws of the universe, this deliberate intervention of science in the affairs of life and of the universe,—could all this be the work of his own time? He knew it too well to venture to hope it himself, and it is on this account, doubtless, that he placed the fortunate country which enjoyed so noble an institution in the solitude of the great ocean.

Two centuries and a half ago the conception of Bacon was regarded as a noble utopia; to day it is a reality. That magnificent programme which he then drew out, is ours, gentlemen; ours, not in the narrow sense of the word, for I extend this programme to all who, in modern times and in all countries, give themselves to the search for truth, to all workers in science, humble or great, obscure or famous, who form in reality, in all parts of the globe and without distinction of nationality, that vast association which was the dream of Francis Bacon. Yes, science is now a neutral field, a commonwealth, placed in a serene region, far above the political arena, inaccessible, I wish I could say, to the strifes of parties and of peoples; in a word, this property is the patrimony of humanity. It is, too, the principal conquest of this century, which my illustrious predecessor characterised, with so much justice, as the century of science.

Modern generations are spectators, indeed, of a magnificent spectacle. For a century past the human mind has directed an immense effort to the study of the phenomena and the laws of the physical universe. Hence an astonishing development of all the sciences founded on observation and experiment. New ideas which have arisen in our days in the correlation and conservation of forces have been like a revelation to some of these sciences.

Mechanics, physics, chemistry, physiology itself, have found at once a *point d'appui* and a bond of connection. And this powerful flight of ideas has been sustained by the progress of the methods, I should say by the more careful exactness of observations, the perfect delicacy of experiments, the more rigorous severity of deductions. These are the springs of this movement which hurry along the sciences, and of which we are the astonished and moved witnesses. It is to propagate it broadcast over our country that we hold, each year, this parliament, to which are invited all who take part or are interested in the war against the unknown. Science is indeed a war against the unknown; for, if in literature it is enough to give expression, and in art a body, to conceptions or beauties deposited either in the human mind or in nature, it is not so in science, where truth is deeply hidden. She must be conquered, she must be stolen, like the Promethean fire.

It is of some of these conquests that I wish to speak to-day, full of doubt and apprehension in presence of so great a task. To respond to the demands of his position and to follow noble examples, your president ought, at the beginning of this session and of the ceremonies which inaugurate our young association, to trace the progress accomplished in the sciences, mark by a few bold lines the various routes over which it has recently run, and the culminating points which it has attained. I shrink from such a programme: if it does not exceed the powers of some of my colleagues, and doubtless of some among you, it greatly surpasses mine. Less justified and less daring than was Condorcet at the end of last century, I only perceive the outlines and some bright patches of the sketch which he attempted to draw; and to see it accomplished, I shall call to my assistance those who will follow me in the honourable and perilous post I now occupy.

I shall confine myself, then, gentlemen, to speaking to you of what I know, or of what I think I know, by directing your attention to the science to which I have devoted my life.

Chemistry has not merely grown, it has been regenerated since Lavoisier. You know the work of that immortal master. His labours in connection with combustion gave to our science an immovable basis by fixing at once the notion of simple bodies and the essential character of chemical combinations. In these latter we find in weight all that is ponderable in their elements. These, in uniting to form compound bodies, do not lose any of their proper substance; they lose only an imponderable thing, the heat disengaged at the moment of combination. Hence that conception of Lavoisier that a simple body such as oxygen is constituted, properly speaking, by the intimate union of the ponderable matter oxygen with the imponderable fluid which constitutes the principle of heat, and which he named caloric—a profound conception, which modern science has adopted, giving it a different form. It is, then, unjust that, in recent times, Lavoisier should be accused of having misconceived what is physical in the phenomenon of combustion, and that an attempt should be made to rehabilitate the doctrine of Phlogiston which he had the honour of overturning. It is true that in burning bodies lose something: "It is the combustible principle," said the partisans of Phlogiston; "It is caloric," said Lavoisier; and he adds, an essential thing, that they gain in oxygen.

Thus Lavoisier perceived completely the phenomenon, of which the great author of the phlogiston theory, G. E. Stahl, had only a glimpse of the external appearances, and of which he misconceived the characteristic feature. Such is, gentlemen, I maintain, the foundation and the origin of modern chemistry. Is that to say that the monument raised upon these bases by Lavoisier and his contemporaries subsists in all its parts, and that it was accomplished at the end of last century? It would not be from want of materials, and even in its outlines we may notice lines which have in time disappeared. It has then been added to and in part transformed; but it still rests upon the same foundations. Such has been in all sciences and in all times the lot of theoretical conceptions; the best of them contain obscurities and gaps which, on disappearing, become the occasion of important developments or of a new generalisation.

That of Lavoisier embraced especially the bodies best known in his time, *i. e.*, the compounds of oxygen, the true nature of which was discovered by him in his researches on combustion. All these bodies are formed of two elements; their constitution is binary, but it is more or less complicated. Some, oxides or acids, contain a simple body united to oxygen; others, more complex, are formed by the combination of acids and oxides among themselves, a combination which gives rise to salts. These last then are formed of two constituent parts, each of which contains oxygen united to a simple body. Such is the formula of Lavoisier on the constitution of salts; it is in harmony with the fundamental idea which he enounced on chemical combination, an idea according to which all compound bodies are formed of two immediate elements, which are either simple bodies or themselves compound bodies.

This dualistic hypothesis was embodied, in his time and with his consent, in French nomenclature, the work of Guyton de Morveau, the principle of which may be thus summarised: two words to designate each compound, one to mark the genus, the other the species. Thus, one of the fundamental conceptions of the system of Lavoisier—dualism in combinations—found a striking expression in the binary structure of the names, and is, as it were, insinuated into the mind by the very terms of chemical language; and we know what is, in such a case, the power of words.

The great successor of Lavoisier, Berzelius, extended to the whole of chemistry the dualistic hypothesis of Lavoisier on the constitution of salts. Wishing to give it a solid support, he added to it the electro-chemical hypothesis. All bodies are formed of two constituent parts, each of which possesses, and is, as it were, animated by, two electric fluids. And as the electro-positive fluid attracts the electro-negative, it is natural, it is necessary that in every chemical compound the two elements should reciprocally attract each other. Is not the one carried towards the other by electric fluids of opposite kinds? We see that the hypothesis of Berzelius gives at once a striking interpretation of the dualism in combinations and a simple and profound theory of chemical affinity. This elective attraction which the final particles of matter exercise upon each other was referred to electric attraction.

Another theoretic conception gave a body to the electro-chemical hypothesis, and has given since a solid basis to chemistry as a whole. We speak of the atomic theory, revived from the Greeks, but which took, at the commencement of this century, a new form and a precise expression. It is due to the penetration of an English thinker, a teacher of chemistry in Manchester in the beginning of the century. It was less a pure speculation of the mind, as were the ideas of the ancient atomists and of the philosophers of the Castesian school, than a theoretical representation of well-established facts, viz., the parity of the proportions according to which bodies combine, and the simplicity of the relations which express the multiple combinations between two bodies.

Dalton found, in fact, that, in cases where two substances combine in several proportions, if the quantity of one of them remains constant, the quantities of the other vary according to very simple relations. The discovery of this fact was the starting-point of the atomic theory. Here is the substance of this theory:—That which fills space, viz. matter, is not infinitely divisible, but is composed of a universe of invisible, imperceptible particles, which, nevertheless, possess a real extension and a definite weight. These are atoms. In their infinitely attenuated dimensions, they offer points of application to the physical and chemical forces. They are not all like each other, and the diversity of matter is owing to inherent differences in their nature. Perfectly identical for the same simple body, they differ from one element to another in their relative weights, and perhaps by their form. Affinity sets them in motion, and when two bodies combine with each other, the atoms of the one are drawn towards the atoms of the other. As this approach always takes place in the same manner between a determinate number of atoms, which are in juxtaposition one to one, or one to two, or one to three, or two to three—in other words, according to very simple proportions, but invariable for a given combination—it results therefrom that the smallest particles of this combination present a fixed composition rigorously similar to that of the entire mass.

Thus the most important fact of chemistry, the immutability of the proportions according to which bodies combine, appears as a consequence of the fundamental hypothesis that chemical combinations result from the coming together of atoms possessing invariable weights. Berzelius compared these atoms to minute magnets. He imagined them to have two poles where the two electric fluids are separated but unequally distributed, so that one of them is in excess at one of the poles. "There exist," he said "atoms with excess of positive fluid and others with excess of negative fluid"; the first attract the second, and this attraction, the source of chemical affinity, preserves the atoms under all combinations. At the moment that these last are formed they are set in motion; in the completely formed compound they are at rest, and are divided as if into two camps, at once kept together and maintained in opposition by the two electric fluids of opposite kinds.

Thus the electro-chemical theory, ingeniously adapted to the hypothesis of atoms, raised the dualism of Lavoisier to the digunity of a system, which appeared solidly established during the first half of this century. The facts then known were included in it without difficulty, and the rich materials which the patience or the genius of experimenters amassed without ceasing were very soon co-ordinated.

Without attempting to enumerate the older works relating to the decomposition of alkalis, to the nature of chlorine recognised as a simple body, to various newly-discovered elements, such as selenium, tellurium, iodine, we shall mention in a special manner among so many discoveries, that of cyanogen, which we owe to our own Gay-Lussac. The demonstration of the chemical functions of this compound gas, which behaves like a simple body, which is capable of forming the most varied combinations with true elements, which finally, when it is engaged in such combinations lends itself to double decompositions, as does chlorine in the chlorides, was a great step in the progressive march of science. Hence the definition: cyanogen is a compound radical, and the triumphant appearance of the doctrine of radicals. It had been vaguely intimated by Lavoisier; it really dates from the discovery of cyanogen, and will make a rapid advance. Up to that time great efforts had been directed to the side of inorganic chemistry, and great ideas had arisen in this domain. The application of these ideas to organic chemistry, upon which attention then began to be directed, presented some difficulties.

We know that the innumerable bodies which nature has distributed in the organs of plants and animals contain a small number of elements—carbon, hydrogen, oxygen, and often nitrogen. It is then not in their general composition that they differ, but by the number and arrangement of the atoms which enter into their composition. By increasing more or less and grouping themselves in various manners, these atoms give rise to an immense multitude of distinct compounds which are true chemical species. But what is the arrangement of these atoms? What is the structure of these organic molecules, so much alike in the nature of their elements, so wonderful in the infinite diversity of their properties? Berzelius solved this question without hesitation. Comparing organic compounds to the bodies of inorganic chemistry, he divided both classes of atoms into two lots, grouping on one side carbon and hydrogen, electropositives, and on the other, oxygen, electro-negative. And when, at a later time, chlorine was artificially introduced into organic compounds, the atoms of this powerful element were ranged on the side of oxygen. both being invariably found in binary combinations of which they formed the electro-negative element, the atoms of carbon and hydrogen constituting the electro-positive radical.

Thus the great promoter of inorganic chemistry attempted to fashion organic molecules according to the image of those molecules of dead matter which he had studied so thoroughly. The paths which Lavoisier traced in this domain he wished to extend to the world of products formed under the influence of life; they resulted in a dead-lock. In proportion as the riches of science increased it was necessary, in order to uphold the system, to accumulate hypotheses. to invent radicals, to construct, with insufficient or imaginary data, formulæ more and more complicated —a thankless task, in which the feeling of experimental realities and sober appreciation of facts often gave place to outrageous reasonings and vague subtleties. These barren efforts of a great mind inaugurated the decline or marked the termination of the dualistic ideas which were at the foundation of what has been called, improperly perhaps, the old chemistry. The new began at that point. Great discoveries, cleverly and boldly interpreted, gave it an impulse which still endures.

There were then—I speak of forty years ago—a number of young men, with Dumas and Liebig at their head, in the opposite camp, who cultivated with ardour the investigation of organic compounds. Convinced that the constitution of these compounds could only be deduced from the attentive investigation of their properties and metamorphoses, they undertook to investigate these bodies themselves, to transform them, to torment them in some sort by the action of the most diverse reagents, in the hope of discovering their intimate structure. And this is, gentlemen, the true method in chemistry; to determine the composition of bodies, and by careful analysis of their properties to fix, as far as possible, the grouping of their ultimate particles. This, then, is the glory of our science, and the single but precious contribution which it is able to furnish for the solution of that eternal problem, the constitution of matter.

From the researches which were made at this epoch and in this spirit, an all-important fact issued; it relates to the action of chlorine on organic compounds. This simple body deprives them of hydrogen and may be substituted for that element, atom for atom, without affecting the molecular equilibrium and without, adds Dumas, modifying the fundamental properties. This proposition encountered at first the most violent contradiction. How could chlorine take the place of hydrogen and play its part in combinations? These two elements, said Berzelius, are endowed with opposite properties, and if the one is lacking the other cannot supply its place; for, in short, they are two inimical brothers, little disposed and by no means fit to be kept in the same house. These critics and many others have not prevailed against facts. The theory of substitutions has come triumphantly out of this great discussion, which marks a date in the history of our science. Its natural development has gradually introduced into it new ideas on the constitution of chemical compounds, on the mode of combination of the elements which they contain.

These ideas have come to light by various ingenious comparisons. Laurent considered organic compounds as formed of nuclei with appendages, both the one and the other admitting into their structures atoms grouped with a certain symmetry. Dumas compared them to edifices of which the atoms constitute, in a manner, the materials. Hence the graphic but frequently correct expression, of molecular edifices capable of being modified, in certain cases, by the substitution of one part for another, and which, in other cases, the shock of powerful reagents may shatter to pieces. In both conceptions the chemical molecules were regarded as forming a whole. A little later Dumas compared them to planetary systems; and here he veritably shot ahead of his time in giving us a glimpse of groups of atoms maintained in equilibrium by affinity, but carried along by movements, as the planets of a solar system are acted upon by gravitation and carried into space. It is in these movements of atoms and molecules that at a later period the source of the physical and chemical forces must be sought for; but I must not anticipate. I have attempted to show how the ideas on chemical combinations have been gradually modified under the double influence of the atomic hypotheses and of facts brought to light by the French school concerning their reciprocal replacement in combinations. Forming a whole, more or less complex, the molecules of organic substances may be modified by substitution and give rise to a multitude of derivatives which naturally attach themselves to the mother substance. The latter serves them as a model or type. The typical idea thus introduced into science very soon occupied a large place. It first brought to it important elements of classification. All the compounds derived by substitution from the same body were ranged in the same family, of which the latter was, so to speak, the chief. Hence arose groups of bodies perfectly distinct from each other, and the number of which were being constantly increased by daily discoveries. It was necessary not only to introduce order into all these tribes, but to connect them with each other by a common bond. The honour of having discovered the superior principle of classification belongs to Laurent and Gerhardt, valiant champions of French science, from whom premature death has snatched, if not victory, at least the gratification of victory. Laurent was the first to say that a certain number of mineral and organic compounds possessed the constitution of water, and this idea, brilliantly developed by Williamson, was generalised by Gerhardt. According to the last named, all inorganic and organic compounds may be connected with a small number of types, of which hydrochloric acid, water, and ammonia, are the chief. In these compounds, relatively simple, one element may be replaced by another element, or by a group of atoms performing the function of a radical, so that this substitution gives rise to a multitude of various compounds bound together by the analogy of their structure, if not by the harmony of their properties.

This last point was novel and important. Bodies belonging to one type and similar in their molecular structure may differ much in their properties: these depend not only on the arrangement of the atoms, but also on their nature. Thus the inorganic and organic bodies ranged under the type water, are, according to the nature of their elements or their radicals, powerful bases, energetic acids, or indifferent substances—a great and bold idea, which has established a connection between the most diverse bodies, and which has definitely overturned the barriers which use had raised, and which the weakness of theory had maintained, between inorganic and organic chemistry. And yet this was only a stage in the march of ideas. By what right and by what privilege, it was said, may the relatively simple compounds we have named serve as types for all others, and why should nature be restricted to make all bodies on the model of hydrochloric acid, water, and ammonia? This was a serious difficulty, but it has been removed; it became the occasion of a profound discussion and the germ of a real progress.

These typical compounds represent at bottom various forms of combination, the diversity of which it is necessary to refer to the nature of the elements themselves. The latter impress on each of these compound types a particular character and a special form. The atoms of chlorine are so formed that to one of them only a single atom of hydrogen needs to be added to form hydrochloric acid; then that an atom of oxygen takes two atoms of hydrogen to form water; that an atom of nitrogen requires three to constitute ammonium, and that an atom of carbon demands four to become marsh-gas. What a difference in the power of combination of these elements, and, so to speak, in their appetites for hydrogen! And will this difference not be connected with some peculiarities in their mode of existence, to some property inherent in matter itself, and which will impress on each of these hydrogenic compounds a special form? Such is the case.

It is now admitted that atoms are not motionless, even in bodies apparently the most fixed and in completely formed combinations. At the moment when these are being formed the atoms come into violent collision with each other. In this conflict a disengagement of heat is ordinarily observed, resulting from the expenditure of active energy which the atoms have lost in the *mêlée*, and the intensity of this heat-phenomenon gives the measure of the energy of the affinities which have presided at the combination. But there is another thing in chemical phenomena besides the intensity of the forces at work, and which are more or less exhausted by a disengagement of heat; I refer to their *mode;* it was of this elective attraction that Bergman spoke a century ago, and which governs the form of the combinations. The atoms of the various simple bodies are not endowed with the same aptitude for combination with each other; they are not equivalent to each other. This is what is called atomicity, and the fundamental property of atoms is without doubt connected with the various modes of motion by which they are animated. When these atoms combine with each other, their movements require to be reciprocally co-ordinated, and this co-ordination determines the form of the new systems of equilibrium which will be formed; that is, the new combinations.

It is with atoms thus endowed that chemists now construct molecular edifices. Resting at once upon the data of analysis and on the investigation of reactions, they express the composition of bodies by formulæ which mark the nature, the number, and the arrangement of the atoms which each molecule of these bodies contains. But what! is this merely an ingenious exercise of the mind? and the construction of formulæ by means of these symbolic materials which are selected, which are arranged so as to give to the molecular edifice a determined form,—is this a mere matter of curiosity? By no means. These formulæ, by whose aid are expressed the composition of bodies and the constitution of their molecules, offer also a valuable aid for the interpretation of their properties, for the study of their metamorphoses, for the discovery of their reciprocal relations,—all things which are intimately connected in each body with the nature and arrangement of the atoms. Now, the investigation and comparison of these formulæ furnish to the inquiring spirit the elements of a powerful synthesis. What treasures have been acquired by science by this process, which consists in deducing the transformations of bodies from their molecular structure, and in creating, by a sort of intuition, new molecules by means of those already known! The artificial formation of a number of combinations, the syntheses of as many organic compounds as nature alone seemed to have the privilege of forming—in a word, the greater part of chemical discoveries which have enriched science and the world for twenty years—are founded on this inductive method, the only efficacious and the only rational one in the sciences. I shall cite only one example among many others.

A happy chance led to the discovery of that brilliant substance, of a bright purple, which is known under the name of fuchsine or rosaniline. Analysis determines its composition, skilled investigations find its molecular structure. Soon it is known how to modify it, to multiply the number of its derivatives, to vary the sources of their production, and from attentive study of all these reactions, issue a pleiad of analogous substances whose diverse colours rival in brilliancy the richest tints of the rainbow. A new and powerful industry has already resulted from all these investigations, which theory has followed step by step and guided the fertile evolution. In this order of investigation, science has recently gained one of her most striking triumphs. She has succeeded in forming at once the colouring matter of madder (alizarin). By an ingenious combination of reactions, and by theoretic reasonings still more ingenious, MM. Graebe and Liebermann have succeeded in obtaining this body synthetically, by means of anthracene, one of the numerous bodies which is now obtained from coal-tar, the impure source of so many wonders. Such is a discovery which has issued from the womb of science, and of science the most abstract; confirming preconceived ideas on the relations of composition and of atomic structure between anthracene, alizarin, and the intermediate terms. And this will not be the last product of this beautiful development of chemistry. Future conceptions on the intimate structure of complex organic compounds will be so many landmarks for new syntheses, and hypotheses rigorously deduced from acquired principles will be fruitful in the happiest applications.

Saccharine matters, alkaloids, other complex bodies whose properties and diverse transformations are actively investigated with a view of deducing their molecular constitution—all these substances may be artificially reproduced, as soon as this preparatory work, so difficult and often seemingly so useless, will have sufficiently advanced. So fine a programme justifies the great efforts which have been made, in our days, in this direction. To discover, to analyse, to study, to classify, reproduce artificially so many diverse substances, to study their internal structure, to indicate their useful applications; to surprise, in a word, the secrets of Nature and to imitate her, if not in her processes, at least in some of her productions—such is the noble aim of contemporary science. She can only reach it by the sure but slow paths we have indicated; experiment guided by theory. In chemistry, at least, empiricism has had its day; problems, clearly stated, must be boldly faced, and henceforth the rational conquests of experiment will only leave a place more and more circumscribed for fortunate finds and the surprises of the crucible. Away, then, with the detractors of theory, who go in quest of discoveries which they can neither foresee nor prepare; they reap where they have not sown. But you, courageous workers, who trace methodically your furrows, I congratulate you. You may be sometimes deceived, but your work will be fruitful, and the goods which you amass will be the true treasure of science.

Will not this science be one day embarrassed and as if encumbered with so much riches, and will the strongest memory be able to support all the weight? If the danger exists, there is no need to fear it. The classification of all these materials will free us from embarrassment. In a well-arranged edifice, each stone requires to be prepared before taking its place; but the construction accomplished, all do not strike the eye equally, though each has its use; only the strong courses, the corner-stones and the salient parts, are noticed. It will be thus with the monument of science. The details which have for their end to fill up gaps will disappear in the great whole, of which we only need consider the foundation, the principal lines, and the crowning of the edifice.

Gentlemen, chemistry thus constituted, and physics, have between them necessary connections. Both the one and the other investigate the properties of bodies, and it is evident that, so far as the ponderable bodies are concerned, these properties must be intimately connected with the constitution of matter. Hence the atomic hypothesis which suffices for the interpretation of chemical phenomena ought also to be adapted to physical theories. This is the case. It is in the movements of atoms and of molecules that we now seek, not only the source of the chemical forces, but the cause of the physical modifications of matter, changes of condition which it can undergo, phenomena of light, of heat, of electricity, of which it is the support.

Two French *savans*, Dulong and Petit, discovered some time ago a very simple law which connects the weights of atoms with their specific heats. It is known that the quantities of heat necessary to change by one degree the temperature of the unit of weight of bodies are very unequal. This is what we call specific heat; but the quantities of heat which bring about in simple bodies, taken under conditions in which they are rigorously comparable, the same variations of temperatures, are equal, if we apply these quantities of heat not to the unit of weight but to the atomic weight; in other words, the atoms of these elementary bodies possess the same specific heats, though their relative weights are very unequal.

But as to this heat which is thus communicated to them, and which raises their temperature equally, what is in reality its mode of action? It augments the intensity of their vibratory movements. Physicists recognise heat as a mode of motion, and that it comes under the cognisance of our perceptions by the vibrations of atomic matter or ether; of ether, that fluid material perfectly elastic, incoercible, imponderable, which fills all the immensity of space and the depth of all bodies. It is in this fluid that the stars describe their orbits; in this fluid atoms perform their movements and describe their trajectories. Thus the ether, the radiant messenger of heat and light, conveys and distributes their radiations through all the universe; and that which it loses in vibratory energy when it penetrates a cold body, which it warms, it communicates to the atoms of this body and augments the intensity of their movements; and that which it gains in energy by contact with a warm body, which it cools, it withdraws from this body and diminishes the intensity of their vibratory movements. And this kind of light and heat which comes from material bodies is transmitted across space to other material bodies. You will remember in reference to this the words which Goethe put into the mouth of the Prince of Darkness in cursing the light—"It is born of bodies, it is brought forth and maintained by bodies, and it will perish with them."

But this exchange of forces which circulate from ether to atoms and from atoms to ether, must it manifest itself always in the phenomena of light or heat? This vibratory force which is transmitted by ether, can it not be preserved and stored up by matter, or appear under other forms?

It can be preserved as affinity, liberated as electricity, transformed into dynamic movements. It is this which is stored up in the innumerable compounds elaborated by the vegetable kingdom; it is this which provokes the decomposition of carbonic acid and of the vapour of water by the most delicate organs of plants which blossom in the sunlight. Originating with the sun, luminous radiation becomes affinity in the immediate organic principles which are formed and accumulated in vegetable cellules. That mode of motion of ether which was "light" is become another mode of motion which is "affinity," and sways the atoms of an organic compound. In its turn this force thus stored up is expended again when the organic compounds are destroyed in the phenomena of combustion. Affinity, satisfied and as it were lost by the combination of combustible elements with oxygen, again becomes heat or electricity. Wood in burning, and carbon in becoming oxidised, produce sparks or flames: a metal which exhausts its affinities in decomposing an acid warms the liquid or, under other conditions, produces an electric current, warming it less when the current is exterior. And in another order of phenomena, heat which distributes or propagates itself unequally between two surfaces, rubbing one against the other, or in a crystal that is warmed, or in two metals united by solder, disappears partially as such and manifests itself as static electricity or as an electric current. Thus all these forces are equivalent to one another and appear under diverse forms, whether they are passing from atoms to ether or from ether to atoms; but we never see them disappear or lose their force—only transform themselves and perpetually renew their youth.

And this is not all. These vibratory movements which sway atoms and which whirl about in ether can cause movements of the mass, displacement either of the bodies or of the molecules. Warm a bar of iron, it will dilate with a force almost irresistible; a part of the heat will be employed in producing a certain pull-asunder of the molecules. Warm a gas, it will in like way dilate, and a part of the heat disappearing as such, will produce a separation very considerable in this case between the gaseous molecules; and the proof of the consumption of heat in work of dilation is not difficult to give, for if you warm the same gas to the same degree, but prevent it from dilating, less heat need be given to it than in the former case. The differance between the two quantities of heat corresponds exactly to the mechanical work performed by the molecules in dilatation. That is one of the most simple considerations, on which is founded the principle of the mechanical equivalent of heat so often now referred to in mechanics, in physics, and in physiology.

In physics it explains the mystery of latent heat, of fusion, and of volatilisation. But how is it that heat supplied continuously to a boiling liquid to maintain ebullition does not ever raise the temperature of the liquid above a point which under similar pressure remains fixed? The reason is that this heat is continually absorbed, and diappears as such to produce the mechanical work of driving apart the molecules. And so in the phenomena of fusion, the constancy of the temperature indicates the absorption of the heat consumed in molecular work. These conceptions have modified and thrown much light on the definitions which physicists have applied to different states of matter, and it is seen that they are in harmony with chemical theories of the constitution of bodies. These are formed of molecules which represent systems of atoms animated by harmonic movements, and whose equilibrium is exactly maintained and strengthened by these movements.

Applied to molecules thus constituted, heat can produce three different effects. In the first place, an elevation of temperature by the increase of vibratory energy; in the second place, an increase of volume by the driving apart of atoms and molecules, and this augmentation becoming very considerable, a change of condition, solid becoming liquid, and liquid becoming gas; in the last, the driving apart of the molecules is become immense in relation to their dimensions. Thus acting on the atoms which compose the molecule and amplifying their trajectories, heat can disturb the equilibrium which exists in the system, causing a conflict of these atoms with those of another molecule in such a way that this disturbance or this conflict leads to fresh systems of equilibrium, that is to new molecules. There commence the phenomena of decomposition and dissociation, or, inversely, of combination, which is the main spring of chemistry, and it is seen they are but the continuation or consequence of the physical phenomena we have just analysed, the same hypothesis, that of atoms, applied to one and the other with an equal simplicity.

I ask, will it not be easy to conceive that the physical and chemical forces which act on ponderable bodies are applied also to diffuse continuous matter in some way, and is it not natural to suppose that there are limited and definite particles which represent the points of application of all these forces? And this view ought to apply to the two sorts of matter which form the universe, ether and atomic matter, the one infinitely rarefied but homogeneous, filling all space, and in consequence enormous in its mass, both unseizable and imponderable; the other non-continuous, heterogeneous, and only occupying a very limited portion of space, although it forms all worlds.

Yes, it forms all worlds, and the elements of ours have been discovered in the sun and in the stars. Yes, the radiations given off by incandescent atomic matter which forms these stars are also, for the most part, those which are produced by the simple bodies of our planet. Marvellous conquest of physics which reveals at once to us the abundance of forces which environ the sun and the simplicity of the constitution of the universe!

A solar ray falls upon a prism and is turned aside in its path and decomposed into an infinity of different radiations. These take each a particular direction, and all range themselves in bands in juxtaposition, and spread themselves out in the spectrum if the light thus received and decomposed is thrown on to a screen. The visible part of this spectrum shines with all the colours of the rainbow; but besides this, beyond both ends of the coloured bands the radiations are not absent. The heat-rays can be made to reveal themselves beyond the red; the chemical rays, more powerful than the others to make and destroy the chemical combinations, are known beyond the violet. All the forces which manifest themselves on the surface of our globe, as heat, light, and chemical energy, are sent to us in a ray of white light.

But this brilliant spectrum is not continuous. Fraunhofer has discovered in it an infinity of black lines cutting the shining band; these are the "dark lines" of the spectrum, and Kirchhoff has found that a certain number of them occupy the same position as the "bright lines" which occur in the spectra of metallic substances when in a state of incandescence. This last physicist, generalising an observation of Foucault, has seen further that under given circumstances these bright lines can be obscured and "reversed," coinciding then with the dark lines of the solar spectrum.

We have been able to conclude that these have an identical origin and are due to radiations given off by metallic substances spread in vapour over the solar globe, radiations which are obscured by these same vapours in the atmosphere of the sun. Thus the star which gives us heat, light, and life, is formed of elements like those which form our globe. These elements are hydrogen and metals in a state of vapour. They are not distributed equally in the mass of the sun and in his rarefied envelopes; the hydrogen and most volatile metals are raised to a greater height on the surface of the sun than are the other metals. They are never in repose; this ocean of incandescent gas is continually agitated by tremendous tempests. The *trombes* throw themselves out in immense columns to the height of 50,000 leagues above the gaseous sphere; these are the "protuberances," and they shine with a rose light peculiar to themselves; and they are formed, according to Jansen and Lockyer, by hydrogen, very rarefied, and also by an unknown substance—"helium." The luminous globe itself, the photosphere, gives the spectra of our ordinary metals, except gold, silver, platinum, and mercury; the precious metals, those which have little affinity for oxygen, being wanting. But, on the contrary, in the solar spectrum there are "lines" different from those which the metals of our earth give, but which are like them. The lines of the metalloids are wanting, as are the lines which are characteristic of compound bodies. The gaseous mass has such an incandescence that no chemical combination could withstand it.

The lines of Fraunhofer are dark, only the lines of the protuberances and those seen a moment after the disappearance of the sun in an eclispe, and a moment before its reappearance, are bright, like those which characterise the spectra of incandescent metallic vapours. Here we have a curious relationship which has furnished most important and precise indications on the physical constitution of the sun.

I have spoken of the chemistry of the sun, but the spectroscope has explored all the far-off space of heaven. The light of hundreds of stars has been analysed, and nebulæ, scarcely visible, have had the quality of their radiations revealed by its aid. The light, in some cases very feeble, with which a number of stars shine, gives a spectrum with dark lines like the solar spectrum, and this fact proves to us that the constitution of these stars is like that of our sun. Aldebaran sends us records of hydrogen, magnesium, and calcium, which abound in solar light, but also those of metals which are rare or absent, as tellurium, antimony, and mercury.

Nebulæ, twenty thousand times less brilliant than a candle at a distance of 400 metres, have still given a spectrum, for their light, although feeble, is very simple in its constitution, and the spectrum which it gives consists only of two or three bright bands, one of hydrogen, the other of nitrogen. These nebulæ which give a spectrum of bright lines, are those which the most powerful telescopes cannot resolve: there is an "abyss" between them and resolveable nebulæ, which, like ordinary stars, give a spectrum with dark lines.

What an effort of the human mind! To discover the constitution of stars of which the distances even are unknown; of nebulæ which are not yet worlds; to establish a classification of all the stars, and still more to guess their ages—ah, tell me, is not this a triumph for science? Yes, we have classed them according to their ages. Stars coloured, stars yellow, stars white; the white are the hottest and the youngest; their spectrum is composed of a few lines only, and these lines are dark. Hydrogen predominates. Traces of magnesium are also met with, of iron, and perhaps of sodium, and if it is true that Sirius was a red star in the time of the ancients, it owed perhaps its tint to the greater abundance of hydrogen at that epoch. Our sun, Aldebaran, Arcturus, are among the yellow stars. In their spectra the hydrogen lines are less developed, but the metallic lines are fine and numerous. The coloured stars are not so hot, and are older. In consequence of their age they emit less vivid light. In them there is little or no hydrogen. Metallic lines abound, but one also finds channelled spaces like the lines of compounds, The temperature being lower, these latter can exist whether they consist of atoms joined to others of the same kind, or whether they contain groups of heterogeneous atoms. In referring recently to this classification of Father Secchi and the distribution of simple bodies in distant stars, Lockyer has observed that the elements the atoms of which are lightest, are to be found in the hottest stars, and that the metals with high atomic weights are, on the contrary, met with in the colder stars; and he adds this—Are not the first elements the result of a decomposition brought about by the extreme temperatures to which the latter are exposed, and taking them altogether, are they not the product of a condensation of very light atoms of an unknown primordial matter, which is perhaps ether?

Thus is brought forward afresh, from considerations taken from the constitution of the universe, this question of the unity of matter which chemistry has before raised from a consideration of the relative weight of atoms. It is not solved, and it is probable that it never will be in the sense here indicated. Everything leads to the belief in the diversity of matter, and the indestructible, irreducible nature of atoms. Does it not require as M. Berthelot has pointed out, the same quantity of heat to put them in motion, whether they are heavy or light, and ought not the law of Petit and Dulong to prevail in its simplicity against the opposite hypothesis, however ingenious it may be?

I have endeavoured, gentlemen, to trace out for you the most recent progress accomplished in chemistry, in physics, and in physical astronomy, sciences so diverse in their object, but which have a basis in common—matter—and one supreme object—a knowledge of its constitution and of its properties and of its distribution in the universe. They teach us that the worlds which people infinite space are made like our own system, and that this great universe is all movement, co-ordinated movement. But new and marvellous fact, this harmony of the celestial spheres of which Pythagoras spoke, and which a modern poet has celebrated in immortal verse, is met with in the world of the infinitely little. There also all is co-ordinated movement, and these atoms, whose accumulation forms matter, have never any repose; a grain of dust is full of innumerable multitudes of material unities each of which is agitated by movements. All vibrates in the little world, and this universal restlessness of matter, this "atomic music" to continue the metaphor of the ancient philosopher, is like the harmony of worlds; and is it not true that the imagination is equally bewildered and the spirit equally troubled by the spectacle of the illimitable immensity of the universe and by the consideration of the millions of atoms which people a drop of water. Hear the words of Pascal: "I wish to picture not only the visible universe, but the immensity of nature that one can conceive within the limits of an atom; one may picture there an infinity of worlds, where each has its firmament, as in the visible universe."

As to matter, it is everywhere the same, and the hydrogen of water we meet with in our sun, in Sirius, and in the nebulæ, everywhere it moves, everywhere it vibrates, and these movements which appear to us inseparable from atoms, are also the origin of all physical and chemical force.

Such is the order of nature, and as science penetrates it further, she brings to light both the simplicity of the means set at work and the infinite variety of the results. Thus, through the corner of the veil we have been permitted to raise, she enables us to see both the harmony and the profundity of the plan of the universe. Then we enter on another domain which the human spirit will be always impelled to enter and explore. It is thus, and you cannot change it. It is in vain that science has revealed to it the structure of the world and the order of all the phenomena; it wishes to mount higher, and in the conviction that things have not in themselves their own *raison d'être*, their support and their origin, it is led to subject them to a first cause—unique, universal God.—*Nature.*

ON A COLLECTION OF HIMALAYAN BIRDS

Recently presented to the Natural History Society by Major G. E. Bulger.

By J. F. Whiteaves.

The collection to which these notes refer, is only a small portion of one of the largest donations the Society has ever received. As an act of simple justice to the donor it is thought desirable to give a short account of previous contributions from the same liberal hand before considering that most recently received. In 1867 Major Bulger presented to the Society no less than 200 skins of Himalayan birds. This collection must have taken no little time, trouble and pecuniary expenditure, to get together. All the specimens were correctly and carefully labelled, not only with the scientific and English name of each species, but also with the local Indian appellations, with exact localities, and often with the name of the collector. The packing was very carefully attended to : the specimens were first put in a strong tin case, which was soldered up so as to be perfectly air tight. A stout wooden box was then made, into which the tin case was fitted, and after the lid had been nailed down, a covering of stout canvass was glued round the package, and over the canvass a thick coat of some waterproof composition was painted. Unfortunately the very care with which the box was packed proved almost fatal to the specimens. The journey was a long and circuitous one, from India round the Cape to England and then to Canada via New York. The package was received in Montreal early in 1868, and it was found that at least two-thirds of the specimens were hopelessly rotten, and that all were badly injured. Perhaps some of the skins were not perfectly dry when they were put in, and it seems probable that if the box had not been air tight, but had allowed tolerable free ventilation to the specimens, they would have arrived in better condition. Be this as it may, the late Mr. Hunter, who was then the Society's taxidermist, and whose abilities in that capacity will be remembered by many of its members, exerted himself to the utmost to save as many as possible. The result was that about 60 specimens were mounted in more or less good order.

Not discouraged by the mishaps which had befallen his first consignment, in 1869 Major Bulger gave the Society a large and interesting series of woods and various other specimens collected in British India, and in the following year a still larger collection of miscellaneous objects, botanical specimens, and seven species of birds from India and Africa. A paper descriptive of a portion of this latter collection will be found on pages 66-75 of Vol. 5 (New Series) of this Journal. The Society is also indebted to this gentleman for the donation of several scientific works, among which are copies of Hooker's Himalayan Journals, and Gould's elaborately illustrated Monograph on the Odontophorine or Partridges of America.

The beautiful collection of the birds of the Neilgherries and Deccan of which these notes are illustrative, was received early in 1873. The specimens, 60 in number, were received in a good state of preservation, and have been mounted by Mr. S. W. Passmore.

The remarks which follow have no claims to originality, their object being simply to call attention to the salient points of interest in the various species in the collection. The general structural peculiarities of the well-known order Raptores or Birds of Prey are too well known even to the general reader to call for any special comment here. To this group belong the Vultures, Buzzards, Eagles, Falcons, Hawks, and Owls, besides other smaller and more critical groups.

In the Buzzards, the beak is straight from the apex to the cere and the mandibles are untoothed. The birds of this section may be recognized also by their usually heavy build, and by their broad, thick, and flat heads.

The Eagles are characterized not only by their large size and powerful frame, but also by the characters of their beaks. In these birds, as in the Buzzards, the beak is straight for a considerable distance from the base, and terminates in a curve or hook. The upper mandible is without teeth but is slightly waved at the side.

In the true Falcons the head is of medium size, the neck is short, as is the bill, which is curved immediately from the base and has its upper mandible conspicuously toothed. The tarsi are short and there is a naked ring round the eye. The wings are very long and pointed.

The Hawks proper have a small head and a long neck, their wings are short and rounded, the tail is long, the tarsi high, and the bare circle round the eye is wanting. The beak is curved directly from the base, but the mandibles are rarely toothed.

There are four species of raptorial birds in the collection under consideration. The first of these, though not labelled, is obviously the Pondicherry fish eagle, the Falco Pontecerianus of Shaw, the Haliastur Indus of recent systematists. As its latest generic name imports, it has affinities with the sea eagles, and, as it seems to the writer, very remote ones indeed with the goshawk. Its systematic place seems to be between the eagles and the buzzards The Pondicherry Eagle, called the Brahminy Kite by European residents in India, feeds to a certain extent on fishes, which it snatches from the surface of the water; but it also preys upon small birds and other animals, including crabs and insects, and will not, so some say, refuse carrion. It is regarded by the Hindoos as sacred to Vishnu. Pearson says among the Mohammedans there is a prevalent notion that when two armies are about to engage the appearance of one of these birds over either party prognosticates victory to that side. Colonel Sykes, who has closely studied the habits of this species, denies that it ever lives on carrion, and says its food is almost always fish, but exceptionally crustacea.

The Kestrel, although in some respects a true falcon, is more slender, fragile, and less powerful than the noble falcons, such as the Gyr and Peregrine. The Kestrels indeed, for there are at least four species, have been separated from the true falcons and have been formed into a separate sub-genus, characterised by a lax and streaming plumage, the comparative weakness of the quills that form the wings, the length of the tail, the strong and short toed feet and lastly by the difference in the colour of the feathers, which varies with the sex. The Common Kestrel is by far the most abundant hawk in Great Britain. It feeds principally upon field mice and shrews, occasionally on small birds, and not unfrequently on earthworms and insects. Selby states that kestrels have been seen, late in the summer evenings, hunting for cockchafers: one was seen to dash among the insects, seize one in each foot and then devour both on the wing. Another writer remarks: "The flight of the kestrel, when searching for its favourite food is very peculiar. It flies gently along at some 30 or 40 feet from the ground, but stops every now and then and remains perfectly stationary, hovering in the air and minutely inspecting the ground beneath it. Should no motion in the grass betray the presence of its prey, it moves on a little farther and again repeats its manœuvres: but as soon as its quarry comes into view, the wings and tail are closed in an instant, and the bird falls like a stone on its victim. Just as it reaches the ground however, the wings and tail are again expanded, the kestrel clutches its prey, and usually goes off with it at once to some place where it can devour it without fear of interruption." This habit of hovering in the air, which, although it is common to many other hawks, is possessed in the greatest perfection by the kestrel, has obtained for it, in some parts of England, the name of the Windhover. The bird is common in almost all parts of the Eastern Hemisphere, but has never been found in America. The so-called Sparrow Hawk of this country, however, belongs to the same subgenus. To show in how little estimation kestrels were held for hawking purposes, a portion of a table enumerating the kinds of hawks proper to be used by persons of various titles, professions, or callings, is taken from an antique volume on falconry quoted in Cassell's Book of Birds:

The Eagle, Merlin, and Vulture, -	for an Emperor.
The Jer Falcon, - - - -	for a King.
The Rock Falcon, - - -	for a Duke.
The Peregrine, - - - - -	for an Earl.
The Lanner, - - - - -	for an Esquire.
The Goshawk, - - - - -	for a Yeoman.
The Sparrow Hawk, - - .	for a Priest.
The Kestrel, - - - - -	for a Knave, or Servant.

The next raptorial bird in this collection is an example of Swainsons or the Pale Chested Harrier. While the Caracara Eagles of Tropical America are considered to be the connecting link between the Buzzards and the Vultures, of all the Hawk tribe the Harriers approach most closely to the Owls. Not only are the eyes of the Harriers unusually large and the plumage soft and downy, as in the owls, but the face is also partially encircled by a ring or ruff of short projecting feathers. The Harriers, it may be observed, are not nocturnal in their habits. While on the one hand the Harriers undoubtedly present strong resemblances to the Owls they have another striking peculiarity in the unusual length of their tarsi. In this respect they are nearly allied to the singular Secretary bird of the dry plains of South Africa. These Secretary birds are snake-eating falcons, with legs as long as those of a heron or crane. They have curious erectile crests, which hang from the back of the head. These, when seen in repose and in profile, resemble a pen stuck behind the ear, hence the name Secretary bird. The Harriers, in general feed upon small quadrupeds such as young hares, rabbits, rats, &c. They also greedily devour birds, sometimes reptiles, but rarely insects and fishes. The specimen exhibited had a lizard in its stomach. When searching for their prey, they fly gently along, at a small elevation, and appear to beat over every part of the ground like a dog hunting for game; to this habit no doubt they are indebted for their name of Harriers. The Marsh Harrier, which from its destructiveness in poultry yards, is called the Hen Hawk in Canada, is common to Europe, Asia and America.

The only Owl in the collection is a small species received without any name, and which has not yet been identified. It seems to belong to that section in which the facial disks are nearly complete, and in which the head is almost destitute of ear tufts.

The birds of prey, the waders, and the swimming birds, have for the most part a very wide geographical range, but the climbing and perching species seem to be confined within comparatively narrow limits. In high northern and in temperate latitudes not a few of the birds of prey are circumpolar in their range but the nearer we get to the equator the less is this the case. Thus, the Peregrine falcon, the Goshawk, Rough-legged Buzzard, Osprey, Golden and White tailed Eagles, and Marsh Harrier, as well as some Owls, are common to the continents of Europe and North America. With the exception of the Marsh Harrier, and perhaps the Goshawk, none of the East Indian birds of prey are to be met with in America, and very few in either Europe or Africa. In warm or semi-tropical countries, the birds of prey are restricted to a very small area. Tropical America, Southern Europe and Asia, Africa and Australia have each their own characteristic genera and species. And lastly, as regards these birds of prey, although there seems to be a northern circumpolar fauna, there does not appear to be the slightest approach to any corresponding antarctic one.

The large order of the Perching Birds, which have three toes in front and one behind, has been variously subdivided. Throughout this paper the classification followed is that adopted at the British Museum. The first division of this order is the Fissirostres, or Gapers, a section characterized by the depth to which the beak is cleft. The most typical representatives of this group are the Goatsuckers and the Swallows.

The Burmese Roller belongs to the typical genus Coracias, in which the bill is flattened sideways. The Rollers are confined exclusively to the Eastern Hemisphere. In tropical America they are represented by the Motmots, Red breasted Crows and Trogons. The Rollers are arboreal in their habits and feed on insects and fruits. They breed sometimes in trees and often in holes in the ground. The European species is called the Birch Jay by the Germans, and the Ultramarine Jay by the Italians. The Rollers are essentially tropical birds.

The Bengal Kingfisher of India and the Crested Kingfisher of the Cape of Good Hope, are fluviatile in their habits, and feed on fish. Like the common British species, which they resemble very closely in colour, both breed in holes in river banks. The Ruddy and the White breasted Halcyons are Tree Kingfishers and mostly inhabit woodland districts often far from water. Their beaks are much broader than those of the true kingfishers, and they have more powerful feet. They live upon insects, such as beetles and grasshoppers, and breed in holes in trees generally at some distance from any water.

The Green Bee Eater of India belongs also to an exclusively Old World group, of singularly elegant and swallow-like form. This species often selects a perch in some prominent position from which it dashes off in pursuit of any insect that comes within sight, returning again to its perch in the same manner as the fly-catchers do. On coming back to their station, Mr. Layard has observed them beating their prey against the perch to bruise it before swallowing it. This mode of capturing food is principally resorted to in the middle of the day, for in the mornings and evenings these same species may be seen hawking about in company with swallows. The habits of the European species were known to Aristotle, who describes it as a great enemy to bees, and as building in holes in the ground. Montague says that in the South of Russia, where the Common Bee Eater is very numerous, the clayey banks of the Don and Wolga are excavated by them to such an extent as to have the appearance of honeycomb. In the Island of Crete the Common Bee Eater is often taken by boys in a singular manner. A Cicada is fastened to a bent pin, or fish hook, which is attached to a long slender line. The insect is then allowed to fly, and as soon as a Bee-

Eater catches sight of it he dashes at it, and swallowing the baited hook is readily captured. In South America and the West Indies, the Bee-Eaters are represented by the Jacamars.

In India the Slender Billed Birds are mostly Sunbirds, which there take the place of the Humming birds of Central America, and the Honey-Eaters of the Australian Continent.

In the third section of the Insessores, the Dentirostres have the mandibles more or less toothed. Among the typical warbling birds in the present collection is a specimen of the Magpie Robin, which in structure is allied to the Redbreast of Great Britain, and in colour only to the European Magpie. In India the Magpie Robin is constantly caged, both for the sake of its song and for its pugnacity. According to Mr. Hodgson, fighting the tame birds is a favourite amusement in India, and he adds that no game cocks can contend with more energy and perseverance than these little birds. The same author states that the professional bird keepers take advantage of this pugnacious disposition in their pets to make them instrumental in the capture of their wild brethren. During the spring it appears the male birds are continually challenging each other, and as soon as one has uttered his note of defiance it is answered by another, and these altercations usually end in a battle. The bird-keeper accordingly carries a tame male on his hand to the nearest garden or grove, when the bird at his bidding utters its challenge, and if this is answered by a wild bird, the tame one is immediately slipped, and a desperate combat commences, in the course of which the man easily secures the wild bird, the tame one actually assisting in the act, by holding its opponent with its bill and claws.

Another warbler in this collection is the Ceylon or Short-tailed Iora, which is allied to the Hedge Accenter of Europe. From the Warblers proper we pass on to the true Thrushes. The Malabar Whistling Thrush belongs to the Formicarinæ or Ant Thrushes. In this group the wings and tail are much shorter than in the typical Thrushes; they feed upon insects and devour large quantities of ants, hence their popular name. The Blue Rock Thrush is the only typical thrush in the collection; it is also, though rarely, found in southern Europe.

The Old World Orioles are very closely allied to the Thrushes, while the American species belong to the Starling family. The Indian Golden Oriole (Oriolus Kundoo) is often called the Mango bird by British residents. It is said (by Jerdon) to have a loud mellow, plaintive cry, something resembling pee ho. The Ceylon or Southern Black Headed Oriole, which is very common in Bengal, has, according to Pearson, a monotonous low note resembling one lengthened full toned note on the flute, which is so constantly repeated as to become a positive nuisance. One species of Oriole is not uncommon in Southern Europe. In Italy, its appearance is said to indicate the time of the ripening of the figs, and indeed the country people fancy they can recognize the words Contadino e maturo lo fico (the peasant of the fig ripening) in its notes. The Orioles live upon insects and fruit, and build in trees.

The Bulbuls are related to the Thrushes on the one hand and to the Flycatchers on the other. They are very sprightly, fine songsters, easily tamed, and very pugnacious. Hence, like the Magpie Robin, they are kept for fighting purposes, and are often exposed for sale in the bazaars of India. They inhabit woods, jungles and gardens, and feed principally upon fruit and seeds, but occasionally also on insects, which they capture on the ground. Allusions to these birds are frequent in the pages of Lallah Rookh. There are 6 representatives of this family in the specimens exhibited. These are

The Red-whiskered Bulbul	-	*Otocompsa rufiventris.* Typical.
The Malabar Green Bulbul	-	*Phyllornis Malabaricus.*
The Common Green Bulbul	-	*Phyllornis Jerdoni.*
The Small Minnivet -	-	*Pericrocotus peregrinus.*
The Short-billed Minnivet	-	" *brevirostris.*
The Orange Minnivet	-	" *flammeus.*

The last sub-family of the Dentirostres is that of the Shrikes. The Ashy Swallow Shrike belongs to a group sometimes called wood swallows, which are peculiar to India and Australia. By several writers these birds are classed with the true swallows, which in some respects they much resemble. By Gray they are placed between the Drongo or Fly-Catching Shrikes (a purely Asiatic group) and the Chatterers. In their powers of flight, the Swallow Shrikes are said to be equal to the swallows and the birds of prey. The fancy of this particular species for certain trees is said to be so strong that where these grow it is often found living at an altitude of 4000 feet above the level of the sea. These birds appear to take their prey, which consists of insects, almost exclusively in the air, and rarely descend to the ground, as their progress on foot is attended with much difficulty. The true Shrikes are the most typical of the Dentirostres, and in them the toothing of the mandibles is best seen. In their strongly hooked bill and curved claws, a close resemblance may be traced to the birds of prey. The Shrikes are eminently carnivorous in their habits, and not only prey upon insects, worms and molluscs, but also on small birds and mammals. From the habit which these birds have of impaling their prey upon sharp thorns before eating it, they are commonly known as butcher birds, and the generic name Lanius applied to them also means a butcher. The Rufous Backed and Hardwicke's Shrike, in the present collection, belong to the type genus Lanius, and are more nearly allied to the Red backed Shrike of England than to the Great Northern or Loggerhead Shrikes of Canada.

The last sub-order of the perching birds is that of the Conirostres, which feed to a large extent on fruit and seeds. The large sub-family of the Starlings is more largely represented in America than in any other part of the world. The Meadow Larks, Grakles, and all the Orioles of tropical America, as well as the Crow Blackbird and Red-Winged Starling, are members of this family. The Mina bird of India is the only specimen of this group in the present collection. A well-known East Indian naturalist thus writes: " The Minas are among the commonest birds in India, Assam and Burmah, where they frequent the neighbourhood of towns and villages in preference to more wooded districts. A tree is usually selected as their sleeping place; and from this point they fly over the country in small parties in search of food, stealing occasionally even into the huts of the natives, in order to obtain cooked rice, of which they are very fond; some follow the flocks and herds, and seize the grasshoppers as they rise from the grass when disturbed by the cattle, others seek subsistence by plundering the gardens and orchards in their vicinity. When upon the ground the Mina walks with ease, constantly bowing its head as it goes, and occasionally springing to a considerable distance; its flight is heavy, direct, and tolerably rapid, and its notes rich and varied. So little fear is exhibited by these birds, that they build almost exclusively in the vicinity of houses, or even in temporary cages that are hung out for their accommodation. In Mosuri, where this species is only a summer visitor, it usually prefers making its nest within a hollow tree. Like the common Starling, it easily acquires the art of speaking, and of imitating a variety of sounds. The Mina has been dedicated by the Indians to their God Ram, and is usually represented as perched upon his hand.'' Major Norgate says of this species. Regular pitched battles are of constant occurrence amongst these pugnacious little creatures; the two combatants, who usually belong to different flocks, coming to the ground, in order the better to carry on their struggle, which is maintained by clawing, beating with the wings, and rolling round each other, screaming loudly as the combat waxes hot: only for a very brief space, however, is the fight confined to these two champions of the rival parties; one after another the rest come down and mingle in the fray, which often rages so fiercely that broken wings or other injuries at last compel the untiring combatants to cease their strife. The same writer describes the Mina's manner of singing as very amusing: "it inflates its chest as though about to make a most tremendous effort, and then gives voice to such a variety of crowing, grunting and squeaking sounds as cannot fail to astonish its hearer. When in flight the notes of these birds are by no means unpleasing; but if alarmed their cry rises to a loud, hoarse shriek, the rest of the party usually joining chorus, till the uproar becomes general. The nest is constructed with the utmost carelessness, and is, in fact, a mere heap of straw, twigs, rags, or even shreds of paper; but in spite of the discomfort of the home thus provided for the young, the latter are tended by both parents with great affection.'' This bird is said to be a special enemy to locusts of all kinds, so much so that the species has been exported from the Philippines to the Isle of France, to rid that island of the locusts with which it was overrun. Under the protection of the Mauritius government, the Minas have increased so rapidly that (according to Bory St. Vincent) they have completely ruined the entomology of the Island.

The Scansores, or climbing birds, which have two toes directed forward and two backwards, are fairly represented in this part of Mr. Bulger's collection. The Rose-ringed and Blossom-headed Parrakeets belong to a long-tailed group of parrots, for the most part characteristic of the East Indies and Australia. The Alexandrine Parrakeet, of the same country, is by many looked upon as identical with the first of these. This is generally believed to be the first parrot known to the ancients, a species having been brought to Europe after the Indian expeditions of Alexander the

Great. In the Reign of Nero, the Romans became acquainted with other kind from Africa. Pliny describes the present birds with sufficient accuracy to identify it. It is, he says, entirely green, with a red collar on the neck. The Romans kept parrots in cages of silver, tortoise shell and ivory, and had tutors who particularly taught them to utter the name of Cæsar; in those days the price of a parrot that could speak exceeded that of a slave. Ovid is well known to have sung their praises, and Heliogabalus thought he could not set anything more delicate than parrots heads before his guests. "Oh unhappy Rome," wrote Cato the censor, "have we lived to see the day when our women nurse dogs upon their laps, and our men go about with parrots on their hands?" The Indian Lorikeet, of which the specimen exhibited was shot at an elevation of more than 2000 feet above the sea level in the Neilgherries, has been classed by some writers among the true Parrots. The Parrots proper have short square tails, and their heads are without crests. The Lories and Lorikeets, which inhabit India and the Eastern Archipelago, are by some naturalists, however, regarded as a peculiar group, distinct from any other, and characterized by having the tongue terminated with a tuft of glutinous filaments or threads. The Barbets are a small group of climbing birds, so called from the base of the beak being surrounded with stiff hairs or bristles instead of feathers. There are three specimens of the Crimson Breasted or Golden Barbet in the present collection. Respecting this bird Jerdon writes as follows: "This species of barbet is found throughout all India, extending into the Burmese countries, Malayana, Ceylon and the Isles; according to Adams, it is not met with on the Himalayas or in the Punjaub. This bird is very common where there is a sufficiency of trees, inhabiting open spaces in the jungles, groves of trees, avenues and gardens, being very familiar, and approaching close to houses, and not unfrequently perching on the housetop. As far as I have observed, it does not climb like the woodpecker, but hops about the branches like other perching birds. The Rev. Mr. Phillips, however, states that it runs up and down the trees like a woodpecker, and other observers have asserted that it climbs to its hole; but I confess I have never seen this, and Mr. Blyth is most decidedly of opinion that barbets never climb. The latter naturalist found that one of these birds which he kept alive would take insects into its mouth and munch them, but swallowed none, and forsook them immediately when fruit was offered. It has a remarkably loud note which sounds like 'took-took-took.' and this it generally utters when rested at the top of some tree, putting its head at each call first on one side and then on the other. Sundevall states that the call is like a low note on the flute, from the lower G to the second E. This sound, and the motion of the head accompanying it, have given origin to the name "coppersmith," by which this species is known by both natives and Europeans. The sound often appears to come from a different direction to that from which it does really proceed; this appears to me to depend on the direction of the bird's head. Mr. Phillips accounts for it by saying that it alters the intensity of its call. Sundevall remarks that the same individual always utters the same note, but that two of these birds are seldom heard to make it alike. When, therefore, two or more individuals are sitting near each other, a not unpleasing music arises from the alternation of the note, each sounding like the tone of a series of bells. The Crimson-Breasted Barbet breeds in holes of trees, laying two or more white eggs. A pair bred in my garden at Saugor on the cross beam of a vinery. The perfectly circular entrance was on the underside of the beam. This nest appeared to me to have been used for several years, and the bird had gone on lengthening the cavity year by year, till the distance from the original entrance was four or five feet; another entrance had then been made also from below about two feet and a half from the nest. Quite recently I discovered a nest built by this bird in a hole of a decayed tree branch, close to a house in a large thoroughfare in Calcutta."

The typical genus Capito, which embraces the Puff birds, is confined to South America, all the other genera are to be met with only in the eastern hemisphere. The two beautiful species of Woodpecker belong to a group usually known as the Ground or Cuckoo Woodpeckers. These are usually less arboreal in their habits than the ordinary kinds, and are somewhat closely allied to the Golden-winged Woodpecker of Canada. They often feed on the ground, in ants' nests and amongst the dung of animals. They are said to be fond of green corn and of fruits, but like the rest of the group sometimes feed on trees and always nidificate in them. Generally speaking, the beaks of the ground Woodpeckers are less robust and strong than are those of the exclusively tree hunting species.

The Cuckoos are the most aberrant members of this family, and indeed they have less the habit of climbing than of perching birds. The Golden Cuckoos are ground Cuckoos, confined to the Eastern Hemisphere, and easily recognized by their tints of golden green and lemon yellow.

By some writers the Pigeons are classed as perching birds, by others among the game birds (Rasores); but Mr. Gray and other writers make a separate order of them. While the beautiful Indian Bronze-Winged Dove is a good example of the ground-loving species, the no less elegant Pin-Tailed Green Pigeon is typical of the Treronidæ or Tree Turtles. Lastly, the gallinaceous birds in this collection are represented by the Common African Quail from the Cape of Good Hope, a species presenting few salient peculiarities or habits calling for special comment.

ON FLUCTUATIONS OF LEVEL IN LAKE ERIE.

By Col. Charles Whittlesey, Cleveland, Ohio

In this paper I present very little in reference to fluctuations of the surface of Lake Erie, which I have not published heretofore. My principal object is to place on record a résumé of those publications, for future reference. The subject was taken up simultaneously in 1838, by the Geological Survey, Ohio, in charge of Professor W. W. Mather, and of Michigan under Dr. Douglass Houghton. When the Survey of Ohio was disbanded in 1839, I continued to make occasional observations, and to collect those made by others, until 1859; when the Lake Surveys of the Government, being then in charge of the late General Meade, adopted a general system of water registers. There have been on each Lake since that time two Meteorological Stations, where readings are taken each day of the height of the water, and all phenomena connected with its fluctuations. These readings will in due time enable the officers of the Survey to discuss the subject, on the basis of reliable facts; from which alone philosophical conclusions can be reached.

But prior to 1859 enough had been determined to show, that there is an *annual* rise and fall of the waters of the Lakes, analogous to the high and low water of large rivers, and due to precisely the same cause.

From the head of Lake Superior to the mouth of the St. Lawrence, the channel must be regarded as one great river with expansions, which is raised by the surplus water of the rainy season, and depressed by the dry season. It is simply the *balance between rain fall and evaporation* over the entire valley of the Lakes; embracing 300,000 square miles. When these two opposite factors shall be obtained by observation, the stage of water can be predicted with as much certainty as the probabilities of the seasons, can be deduced from observations on general meteorology. Both follow a law and are nearly parallel to each other. Both run through cycles of change, returning in periods that are closely similar but which are not regular.

In regard to what I have designated as the general or *secular* changes of level, as distinguished from the *annual*, the former results form the yearly balances. If the annual fall of water equalised for the entire Lake Country is above the average, there must be an accumulation. If it is less, there will be a depression. When several years are on the side of wet, the rise continues each year showing an increase of height, as it was from 1819 to 1838; amounting to a little more than *five feet*. Then a rapid change of the seasons occurred, on the side of drier and more evaporative weather. From 1838 to 1841 inclusive, taking the mean water of each year as a plane of comparison, the water fell 4.15 feet.

Since 1819 the water has not been permanently as low; but in 1846 it reached a point 4.77 below 1838, or within five inches of extreme low water; as at present known. There are, however, causes in operation that increase the suddenness of the discharge of water from the Lake tributaries into the Lakes and thus tend to increase the height of water. If these excessive discharges should occur when other circumstances are in favor of high water, the lakes will reach a higher stage than has been yet known. Thus it it may occur, that the range between high and low water may be greater than *five feet*, and the mean level be somewhat different from what we now put it. For the present it is fixed at two and a-half feet below the flood of 1838; which is five hundred and sixty-four feet above mean tide water at Albany, New York. The city directrix or zero of city surveys, was fixed by an ordinance in 1854 at high water mark of June, 1838, which is also made the zero of most of the railway surveys in Ohio. In a note there will be found some of the bench marks established by the City Engineers.

These two classes of fluctuations, the *annual* and the *general* or *secular*, must not be confounded with those which are temporally due to storms, variation of atmospheric pressure, and aerial movements or undulations; not yet fully understood, and which I have called "*transient oscillations*."

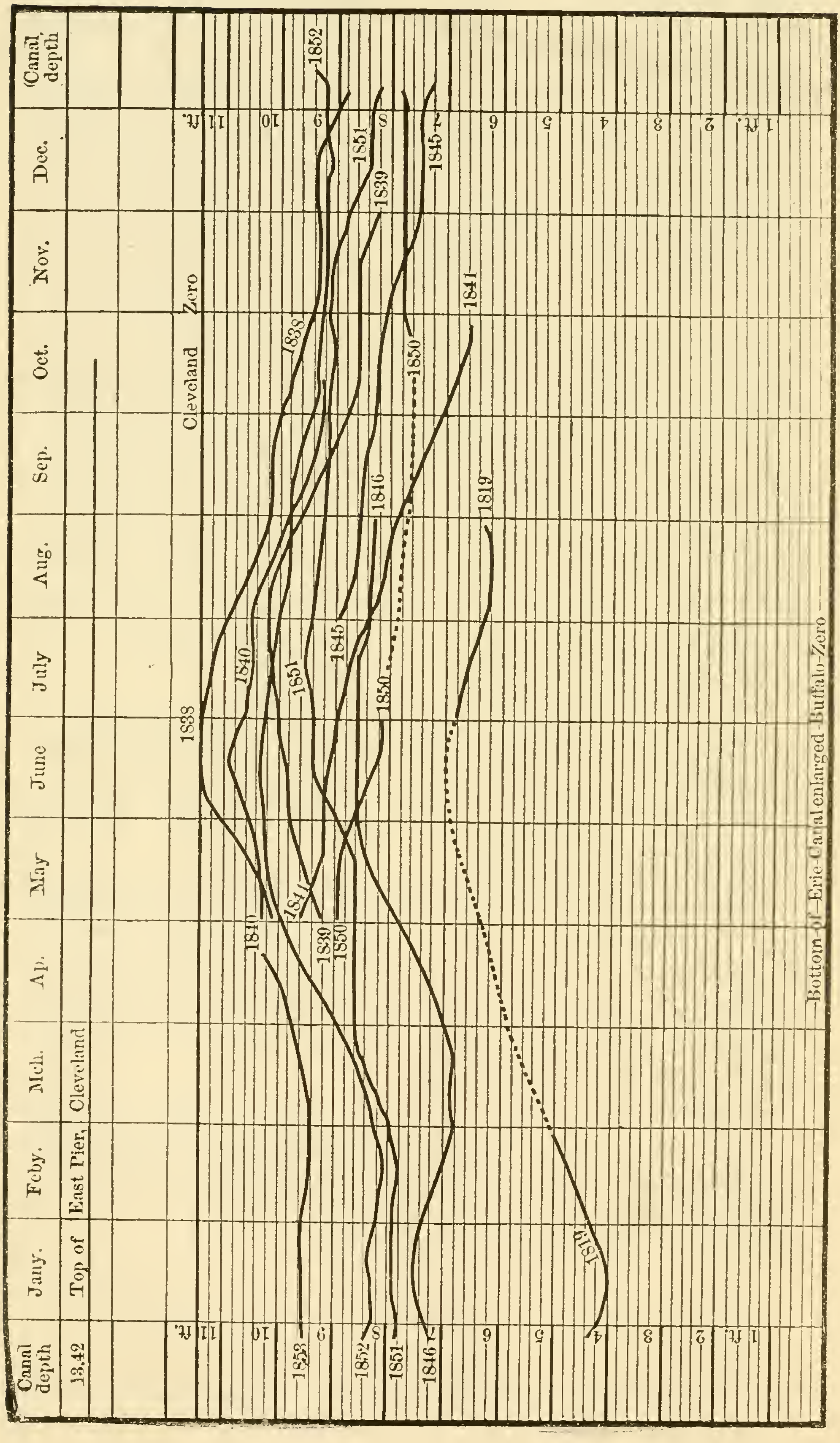
Prior to 1859, there were daily registers kept at Cleveland for only two short periods. The first was by George C. Davies, under the direction of the Government Harbor Agent, Ashbel W. Walworth, Esq., from August to December 1838. Colonel T. B. W. Stockton, who was in charge of the Harbor improvements in 1845-6, caused a full meteorological and water register, to be kept from August 15th, 1845, to September, 1846. A large number of irregular readings were made by the late General

Ahaz Merchant, I. N. Pillsbury, late City Engineer, Captain B. Stanard and myself, extending from 1834 to 1859, but not at regular hours, nor on consecutive days. The labor is too great for any person to undertake who is not employed for that purpose. In addition to the observations made at Detroit, by the first Geological Survey and by A. E. Hathan, City Engineer, and Jacob Houghton as Engineer of the Water Works, there have been a large number of readings at Black Rock, and at Buffalo, New York, by the Engineers of the Erie Canal. All these can be brought together and thus made to supplement each other. On the supposition that the Lake in calm weather is *approximately level*, readings made here and at either of the other places at the *same time*, may be regarded as representing one plane surface. The Detroit gauge is higher than the others by the descent of the river from there to Lake Erie; but the fluctuations are in consonance with those in the Lake, and therefore may be used. After the water tables at Detroit, Cleveland and Buffalo were made out, it appeared that they had some periods of time in common, and thus they could be brought together as one series of observations, good for the entire Lake.

For instance, Mr. John Lothrop, an intelligent engineer in the employ of the State of New York, and myself, made observations for the month of July 1851. The average for that month at Cleveland was 1.96 feet, and at Buffalo 9.46 feet above the metre sill of the guard lock.

This gives for the Cleveland zero 11.42 feet above the Buffalo zero. At Detroit Mr. Hathan used the base of the tower of Water Works, and measured downwards from that as zero. By comparing his tables with ours and disregarding the descent of the river, I find his zero to be 3.43 feet above ours, or 14.85 above bottom of Canal at Buffalo.

In this manner, I have combined all the reliable monthly averages from 1838 to 1853, at the three ports of Buffalo, Cleveland and Detroit, into one expression in the form of curves, as shown in the engraving on the next page.


Canal depth
13.42
Jany.
Feby.
Mch.
Ap.
May
June
July
Aug.
Sep.
Oct.
Nov.
Dec.
Canal depth
Top of East Pier, Cleveland
Cleveland Zero
11 ft.
10
9
8
7
6
5
4
3
2
1 ft.
1838
1839
1840
1841
1845
1846
1850
1851
1852
1853
1819
Bottom of Erie Canal enlarged Buffalo Zero

These results and those which may follow from the Government observations are of great importance to the commercial interests of this Lake. Harbors, piers and channels to be permanent must be constructed with reference to low water. Prior to 1854 the chief of the Topographical Corps, under whose direction the surveys of the Lakes were conducted, paid no attention to these fluctuations.

One of the consequences of this oversight has been the reconstruction of the Canal at the Sault Ste. Marie. Locks that were built to pass vessels of *twelve feet* draft, would at times allow of only *nine feet.* Soundings were referred to no fixed plane. There may be a difference of *five feet*, between the early soundings on the lakes and the true depth of water. Private docks and warehouses are also affected.

The proper plane of reference is that of *mean water level*. Below this, arrangements should be made for a depression of two feet six inches for extreme low water, which may temporarily reach *three feet*.

There is another cause of depression which is having its effect continually; but is so small as to be imperceptible during the life of a generation. This is the perpetual wearing away of the channel at the outlet. On the Upper Lakes there are evidences of a perceptible lowering of the outlets, since they assumed their present general level; but on Lake Erie it is not yet perceptible. It does not probably exceed an inch in a century.

According to tradition among the French residents of Detroit, which was settled in 1701, there has not been since that time as high water as that of 1838.

A conjunction of circumstances such as to cause a state of extreme depression, or extreme high water, will occur only at long intervals, owing to the extent of country drained by the lakes. The tables show that there is no period of *seven* years, or a multiple of seven. This is a popular belief derived from Indians, by the early settlers, which has not yet entirely died away, but which never had the support of observations.

Mean *annual* fluctuation, result of sixteen years' observations	1 ft. 1½ in.
Difference of *highest* and *lowest* months within the year. Cleveland, 4 years obs.	2 " 2 "
Greatest *temporary* difference not due to visible storms. Cleveland	3 " 2 "
Greatest *permanent* difference, 1819 to 1838	5 " 3 "
Greatest *temporary* difference between 1819 and 1838	6 " 11 "

Bench marks in the city of *Cleveland*, referring to city zero, which is the line of high water of Lake Erie in June, 1838, 566.50 feet above mean tide water at Albany, N. York :[*]

1. Surface of stone work, East Pier, 400 ft. from the south end (now lost)	2.00	feet	A.
2. Capt. Meade's U. S. Top. Engineers, 1859, on a pile east of No. 1	2.92	"	"
3. N. E. corner of base water table, Hotel corner of Main and River streets, west side. City Engineer Strong, 1874	3 129	"	"
4. N. E. corner Myers' Stove Works, River street, west side. Asst. Engineer Wheeler, U. S. Survey, 1874	3.127	"	"
5. Door sill, S. west corner of Engine House, C. C. & C. R. Road, Front street. I. N. Pillsbury, City Engineer, 1854	5.829	"	"
6. Coping of west wing wall of canal lock at the Cuyahoga river. R. E. Howe, State Engineer, 1838	6 300	"	"
7. First course of masonry, base of Light House, 3 ft. above ground, Water street; projection of 0.200 ft. over the course below. Asst. Wheeler, Lake Survey, 1874	67.713	"	"
8. N. E. corner of base of Perry Monument. C. G. Force, Asst. City Engineer, 1874	86.533	"	"
9. Mitre sill of guard lock, Erie canal, Buffalo State Engineer, John Lothrop, 1854	11.420	"	B.
10. Base of water works tower, Detroit. A. E. Hathan, City Engineer, 1854	3.439	"	A.

Plane of Soundings at Cleveland :

	Stage of water		
U. States Assistant Engineer, Geo. Fell—fall of 1873	2.500	feet	B.
City Engineer, Chas. Strong, Feb. 1873	2.920	"	"
Col. T. B. W. Stockton, Harbor Agent, April, 1846	4.400	"	"
Lowest water, monthly mean, March, 1846. Stockton's daily register	4.770	"	"
Average low water at Cleveland, Detroit and Buffalo, 1846	4.620	"	"
Extreme low water—by monthly average—1846	5.100	"	"

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[*] Mr. Jos. T. Gardner, Geographer, Washington, D.C., has in connection with the U. S. Coast Survey revised the elevations of the Lake region and the Mississippi valley, by whom mean tide at Albany is 4.84 feet above mean tide at New York.

Elevation of the Great Lakes above the Ocean.[*]

It is not practicable to fix the elevation of the surfaces of these lakes, until their mean fluctuation is known. The results I propose to give, are therefore only approximate.

On Lake Superior the greatest known range of level is three feet, with indications of a much greater range. Lake Ontario has a variation of four feet, nine inches, well determined by water registers, since the year 1812.

The surveys of the Upper Lakes, by the United States Government, now in progress, will eventually fix the mean level of all the lakes, by observations which are made twice each day.

For present use, I give the mean results of instrumental surveys between tide water and the lakes, and between the different lakes.

Before doing this I must remark, that in none of them is the stage of water noted, at the date of the Survey, whether above or below the mean. There is therefore room for a plus or minus error of two or three feet, when referred to a plane, which shall be fixed upon, as the mean level of each lake. There is also another ground of error. The lakes are not strictly level but have an inclination or descent towards their outlets; though this may be small, and in part corrected by the action of winds.

To fix the elevation of the lakes, I begin at those nearest the sea, to which instrumental surveys have been made. The Upper Lakes are not thus connected by direct lines, but their height above tide is determined by reference to those below.

There is quite a discrepancy in the results, which can be accounted for as I have above stated.

LAKE ONTARIO.

By lockage in the St. Lawrence canals, above mean tide,	234½	feet.
By canal surveys of New York, above mean tide, ...	232	"
Mean elevation, ...	233¼	feet.

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[*] In a letter to the Editor, Col. Whittlesey states that this portion of his paper was "inserted in 1866 in a Report on a part of Minnesota," and that the estimates differ somewhat from those which have been recently made by the U. S. Coast Survey. The importance of a "revision of the descent from Lake Ontario to Quebec" is also urged. —Ed.

LAKE ERIE.

By canal surveys in New York, 1817,	561.20	feet.
By Capt. Williams report of 1834, Niagara Ship Canal,	563.00	"
By surveys Caatskill & Portland Railway, 1828,	565 33	"
By locks of New York Canal,	567.00	"
		"
Mean,	564.13	feet.

LAKE HURON.

S. W. Higgins, Geological Report of Michigan, 1838,	577	feet.
A. Murray, Geological Report of Canada, 1849,	578	"
Mean,	577½	feet.
Lake St. Clair, Geological Report Michigan,	570	"

LAKE MICHIGAN.

Southern Michigan Railway, J. H. Sargent Engineer, survey of 1856, south end	583	feet.

LAKE SUPERIOR.

By Cayt. Bayfield's barometical measurement in 1824, 627 feet, evidently too great.		
A. Murray's determination, Geological Survey of Canada, 1849, 599.41 feet, say	600	feet.
Survey of Bay D'Enoch & Marquette Rail Road, 1859,	610	"
Mean,	605	feet.

GEOLOGICAL SURVEY OF CANADA.

Report of Progress for 1873-4.

The Canadian Geological Survey may in one sense be said to be the most extensive in the world. Its territory ranges from the Pacific to the Atlantic and from about the latitude of 45° to the North pole. In another sense it is extremely small, nay almost microscopic, for it seems to have only seven or eight explorers to cultivate all this vast field; and its annual revenue is very small even for this limited corps, especially when we consider the great expense attending expeditions into the more remote parts of the territories of the Dominion. But Canada is beginning to wake up to the importance of science, and the Survey has probably by no means reached its full development. Its resources are indeed to some extent yet based merely on the calculations required for the limited Canada of bygone years, and our public men are only beginning to realise the demands of their present extended territory.

The present report of 266 closely filled pages, ranges over the whole vast field of the Survey from west to east. Beginning at the Pacific, Mr. Richardson writes of British Columbia. The Director himself and Prof. Bell report the results of explorations pushed across the great plains on the lines of the North and South Saskatchewan. Mr. Vennor explored the apatite and plumbago regions of Ontario and Quebec. Mr. McOuat, Mr. Barlow, and Mr. Robb report on the coal-fields of Nova Scotia and Cape Breton; and Dr. Harrington contributes a report on iron, which is really a detailed and almost exhaustive treatise on our resources in that important metal. Mr. Whiteaves concludes the volume with notes on the Cretaceous fossils of British Columbia. Some other departments of work which do not appear in the detailed report, are thus noticed in the introductory remarks of the Director:

"In the Museum the re-arranging, re-labelling, numbering and cataloguing the collections is making satisfactory progress. When completed it is proposed to issue a descriptive catalogue which it is thought will tend materially to enhance the value of the collections both for educational purposes and for the general information of the public. Considering the size and population of Montreal, the comparatively few persons who visit the Museum, only 1000 during the past twelve months, is certainly somewhat remarkable. I believe this arises, however, in a great measure, from the fact that the character and interest of the collection is not generally known. The doors are now open gratuitously to the public every day in the week, Sundays excepted, from 10 a.m. to 4 p.m.; and there are in the cases upwards of seven thousand named specimens of Canadian fossils, minerals and rocks, illustrative of the economic and scientific geology of the Dominion."

"In the library, which already contains upwards of 2000 volumes, comprising standard works of reference on Geology, Mineralogy, Metallurgy, Chemistry and Natural History, important additions are annually made both by purchase and presentation. The latter comprising valuable reports and maps issued by State Geological Surveys in America, Europe, India and Australia, as well as copies of the transactions of various scientific societies sent in return for the publications of the Canadian Survey. Like the Museum, the library is available to the public for purposes of reference and study. Want of space, however, at present is a serious drawback to the realization of its full value, and also prevents the proper arrangement of the books, the numbering and cataloguing of which is now in progress."

"Mr. E. Billings, who has charge of the Palæontological branch of the Survey and Museum, reports that in addition to his duties as Curator he has been engaged in studying and describing fossils from Gaspé and from various localities in Nova Scotia and in Ontario. Some of the results of these investigations are given in Part I, Vol. II, of the Palæozoic fossils of Canada, which is now in the press and will be issued shortly. It will contain about fifty wood cuts and six lithographed plates of fossils with 125 pages of descriptive text."

"Mr. A. H. Foord, the artist to the Survey, has done a large amount of very excellent work in the preparation of drawings and lithographs of fossils to illustrate the geological reports, and for the second volume of the Palæozoic fossils of Canada."

"During the month of August and a part of September, Mr. Foord was engaged collecting fossils from the Devonian rocks at Percé, Gulf of St. Lawrence, required by Mr. Billings, to enable him to complete his description of the fossils of the formation."

" In the early part of the summer Mr. Weston devoted some time, and with considerable success, to a careful search for fossils in the dark earthy limestones associated with the dolomites and serpentines in the Eastern Townships. He also secured there, and subsequently at Arisaig in Nova Scotia, a number of interesting and instructive photographs illustrating the geological structure of these districts. He has likewise during the year made a very large number of sections, mounted for microscopic examination, of rocks and fossils, as well as of recent and fossil woods from various parts of the Dominion."

" The chemical and mineralogical branches of the Survey, are now under the charge of Dr. B. J. Harrington, ably assisted by Mr. Christian Hoffman. Respecting the investigations during the past year in these departments, Dr. Harrington reports as follows:

" The work in the laboratory, as in the previous year, has consisted largely in the examination of economic minerals; although a few rocks and minerals, more especially of scientific interest, have been analysed."

Details as to these analyses which are both numerous and important are given in this Report.

In a scientific point of view the Report adds considerably to our knowledge of the Pacific coast and of the great plains stretching westward from Manitoba to the Rocky Mountains. In the former the fossils collected by Mr. Richardson confirm fully the Cretaceous age of the remarkable coal-field of Nanaimo in Vancouver's Island, and shew also the existence of rocks probably of Jurassic age, underlying these, and appearing in Queen Charlotte's Islands. Fossils have also been found in a still lower series of altered rocks, which are recognized by Mr. Billings as probably of Carboniferous age. Thus in this strange country, the old metamorphic rocks, in aspect like our oldest formations in Eastern America, prove to be Carboniferous, while the workable coals exist in the Cretaceous rocks. In the country east of the Rocky Mountains, Mr. Selwyn and Prof. Bell have ascertained the limits and general relations of Cretaceous and Tertiary beds holding productive lignites and coals over a large region of the plains. They have not, it is true, cleared up all the problems as to the geological age of these beds, which have perplexed the geologists who have laboured in the continuation of these formations further to the south, but they have settled the Cretaceous age of some beds associated with the coals and lignites or immediately underlying them; and whether the lignite beds themselves are to be placed in the Miocene, as Newberry and Heer decide from their fossil plants, or as others hold from their animal forms in the Lower Eocene, or even Upper Cretaceous, it is clear that no decided break either in life or physical conditions separates them from the upper Mesozoic.

In another field, Dr. Harrington's Report, though chiefly practical, is not without features of scientific interest, more especially as to the mode of origin and metamorphism of iron ores. The following extract may serve as an illustration:

" Concerning the origin of our sedimentary magnetites, the question arises as to whether they were originally deposited as such, or in some other form, and afterwards altered to magnetite. It seems possible that, in some cases, beds may have been formed by the accumulation of iron sands, just as they are forming in the Gulf of St. Lawrence to-day, the material being derived from the disintegration of pre-existing crystalline rocks. Such beds we should expect to contain not only magnetite, but ilmenite, and it is well known that in many cases ores on being pulverised may be more or less completely separated into a magnetic portion containing little or no titanic acid, and a non-magnetic portion consisting essentially of ilmenite. It seems, however, probable that in general their origin has been similar to that of the modern bog and lake ores. Deposits of magnetite, as a rule, do not continue of uniform thickness for any great distance like the enclosing rocks, and this is just what might be expected if we suppose them to have originally occurred as bog or lake ores which accumulated in local hollows or depressions. No ore, moreover, would be more readily converted into magnetite than bog ore, on account of the considerable proportion of organic matter which the latter contains."

" In this connection may be described a very simple but interesting experiment tried with a specimen of bog ore from L'Islet, containing about 22 per cent. of water and organic matter. The pulverized ore was placed in a platinum crucible, and heated for an hour at a temperature of 190° F. At the end of that time it had parted with its combined water, or at any rate with sufficient to cause the colour to change from brown to bright red. It still, however, retained organic matter, and on heating for a few minutes in a tightly closed crucible, and at a temperature considerably below redness, a reduction of the peroxide ensued, and a black, strongly magnetic powder was obtained, apparently consisting of magnetic oxide, and not of metallic iron, as it occasioned no precipitation of metallic copper in a solution of the sulphate. The cover was now removed from the crucible and a red heat given, when in a short time the powder again became red, or rather purplish-red, and non-magnetic. Finally, the heat was raised a little higher (to bright redness), and soon the powder became black and strongly magnetic, having apparently parted with a portion of its oxygen. These changes are instructive, for while brought about in the laboratory they might take place in nature. They shew, too, that in some cases magnetites may have been formed from such ores as bog ore at comparatively low temperatures, the reduction being due to the organic matter of the ore."

The Report is rich in information on coal and iron, the two great staples of our mineral wealth. Though the two provinces of old Canada might truly be said to be destitute of coal, this can no longer be affirmed of the Dominion of Canada. In addition to our 18,000 square miles, or thereabout, of coal-formation in the Lower Provinces, we now find at least 100,000 square miles of the western plains underlaid by coal, or lignite which will serve for coal; and beside this there is the valuable, if less extensive Cretaceous coal-area of Vancouver's Island, with others of unknown extent on the mainland of British Columbia. With regard to the district explored by him, Mr. Selwyn writes:

" Dr. Hector has separated the Edmonton coal rocks from those in the vicinity of the Mountain House by an intervening area which he considered to be occupied by a somewhat higher section or division of the Cretaceous series. He did not apparently see the thick seam of coal which I found, as above stated, below the Brazeau River, about eighty-six miles from Rocky Mountain House; and another seam of five feet six inches thick, which I found at a point some fifteen miles higher up the river, as well as the numerous indications of seams which occur between the out-crop of the eighteen feet seam and Edmonton, probably also escaped his notice, as he travelled partly during the night, and in the winter, on the ice, when many of the exposures along the banks must have been concealed by snow. The observations which I was able to make descending the river do not enable me to say whether the seams retain their thicknesses or are connected for long distances, or whether the very numerous exposures and indications seen in the cliff sections represent only more or less lenticular shaped and isolated patches, repeated at different horizons and over large areas. Dr. Hector appears to incline to the latter idea, and, in a note referring to the seams at Rocky Mountain House, he states, 'The coal beds are not continuous for long distances.' Whether this is actually the case or not, there can be no question that in the region west of Edmonton, bounded on the north by the Arthabaska River and on the south by the Red Deer River, there exists a vast coal field covering an area of not less than 25,000 square miles: and beneath a large portion of this area we may expect to find workable seams of coal at depths seldom exceeding 300 feet, and often, as in the case of the thick seams above described, very favourably situated for working by levels from the surface."

Mr. Richardson contributes additional facts tending to prove the value of the coal-fields of British Columbia, in which province there appear also to exist important developments of silver ores. The coal-fields of Nova Scotia and Cape Breton are better known; but important additional facts are stated with respect to them, and the progress which has been made toward the unravelling of the complexities of the disturded coal-strata in the central part of the Cumberland coal-field, is very creditable to the gentlemen engaged in the work.

Iron is next to coal the greatest source of national wealth, and it is only necessary to glance at this part of the Report to see how largely and liberally Canada is endowed with the richest ores of this metal. It is true that in the large Laurentian and Huronian areas, where the most valuable ores of this kind abound, they are remote from mineral fuel, and their value is thereby lessened; but this does not apply to the equally rich and almost equally extensive deposits of Nova Scotia, which are in the immediate vicinity of coal, and which afford the means of making the best iron perhaps more cheaply than any other region in the world. More especially is this true of the deposits in the Cobequid mountains in the vicinity of the coal-field of Cumberland, and of those of Pictou, close to the great collieries of that district. The former have the advantage of having been already partially opened and worked, but the coal-field in their neighbourhood is less developed. The latter are not yet fully opened up in so far as the iron deposits are concerned, but the coal is fully opened, and its adaptation to iron-smelting ascertained. Both have now attracted the attention of capitalists, and unless mismanagement or abnormal political or commercial conditions prevent, will ere long become great and important sources of wealth and centres of manufacturing industry, and will render Canada independent of the rest of the world in so far as its supplies of iron are concerned. It would be impossible to convey any idea of Dr. Harrington's Report by extracts, and te quote references to particular districts might appear invidious. All interested in the development of our mineral resources should study it for themselves. J. W. D.

ON THE CONDITIONS WHICH DETERMINE THE PRESENCE OR ABSENCE OF ANIMAL LIFE ON THE DEEP-SEA BOTTOM.*

By Dr. W. B. Carpenter, F.R.S.

The foundation of Geological Science must be based upon a study of the changes at present going on upon the surface of the earth, including the depths of the sea. This is the distinctive feature of modern Geology. Until recently nothing was really known of the depths of the ocean; but, owing to improved methods of sounding, the bottom of the sea has been reached in so many places, that we may feel tolerably sure that its depth seldom exceeds four miles. Recent statements regarding an extraordinary depth off the coast of Japan, are most probably due to an error similar to that which formerly represented the Straits of Gibraltar as unfathomable—an error caused by the carrying out of the sounding-line in a strong surface-current. The general depth of the Atlantic does not exceed three miles, though, as an exception, the "Challenger" has recently attained 3800 fathoms in a hole 100 miles north of St. Thomas. As an additional proof that this was a true sounding, both the protected thermometers came up crushed.

The temperature of deep water has only lately been ascertained with accuracy, the earlier attempts having been vitiated by the error arising from pressure. Of the older attempts to ascertain the temperature of the deep strata, that devised by Lenz in the second voyage of Kotzebue, though fearfully laborious, gave results that correspond most closely with the "Challenger's"; a fact in scientific annals which has been lately dug out by Prof. Prestwich, and by him brought to the notice of the lecturer, who found his own conclusions—made in entire ignorance of those of Lenz—thus singularly confirmed. The conclusions to be drawn from a study of these temperatures point towards a deep flow of polar water towards the Equator, unrestricted, as regards the Atlantic, towards the south, but limited in the direction of the North Polar area, where there are two principal channels: the one between Greenland and Iceland, the other between the Faroe Islands and the 100-fathom line of North-west Europe, on which platform the British Islands repose. This latter is the "Lightning" channel, the scene of the lecturer's first explorations, the study of which led to his view of the existence of two opposite flows in the great oceanic area, quite irrespective of any one current. In this channel it was found that there was a superficial warm stream and a deep cold stream; and that within a vertical space of 50 fathoms a most marked difference of temperature is suddenly encountered; whilst, as regards horizontal distance, temperatures of 29½° F. and 43° F. have been obtained at the same depth in places not 20 miles apart. These facts mean that there are two distinct movements of water, just as a striking difference in the temperature of the atmosphere indicates a change of wind. Hence, speaking with reference to the "Lightning" channel, it is clear that water much colder than the mean winter temperature of the latitude must have a northerly, whilst water that is warmer must have a southerly source. In accordance with this we find that most of the animals of the cold area, such as the beautiful *Comatula Eschrichtii*, belong to the boreal fauna; whilst British species, such as the common *Solaster papposa*, which is dwarfed from the size of a plate to that of a crown-piece, are much stunted. Yet the fauna is abundant, as no temperature seems to prevent life, so long as sea-water is liquid. Pressure, though enormous, will not affect vital functions; since an animal, whose cavities contain air in aqueous solution only, can contract and expand just as well with a pressure of three tons to the square inch as it can on the surface. Not but what change of pressure, brought on by sudden removal, might produce some derangement. Neither temperature nor pressure, then, being directly of supreme importance, it is the supply of oxygen which has most influence on Animal Life in the deep seas. This is regulated by the general flow of water near the sea-bottom,—a flow not confined to any particular passage or area, but maintained by difference of specific gravity, produced by difference of temperature. As sea-water, in this respect differing from fresh-water, continues to increase in density down to its freezing-point, which is 27° F. if agitated, and 25° F. if still, the Polar column will outweigh the Equatorial column, and there will be a lateral outflow at the bottom towards the equatorial area. This will cause a lowering of water in the polar area, and produce a surface-flow of water from the Equator towards the Poles. The two bottom-flows from either pole will thus meet near the Equator, and rising, will bring cold water nearer to the surface there than anywhere else, except where the surface itself is subjected to cold. In this way the bottom-temperature of the South Atlantic would be lower than that of the North Atlantic, by reason of the less restricted body of the polar flow in the former. The tables given in the "Challenger's" report confirm the conclusions thus arrived at. From these we find that the general temperature of the North Atlantic bottom is about 35½° or 36° F., decreasing to 34° F. near St. Thomas, and under the Equator itself to 32·4° F., the lowest temperature of all. This section proves that the South Atlantic under-flow extends north of the Equator, as had been previously surmised by the lecturer. Only one section was made in the South Atlantic, and no temperatures lower than 33½° F. were there obtained, the expedition not happening to hit upon the channel which brought in the water at 32·4° F. found under the Equator. Most remarkable of all is the line of 35° F. which can be traced across the South Atlantic and then gradually slopes down in the North Atlantic till it is lost. The temperature of the North Atlantic depths is probably about 3° F. higher than in the South Atlantic. Off the coast of Lisbon, in lat. 38° N., the line of 40° F. is found at 700 to 800 fathoms; in lat. 22° N. at 700 fathoms; and on the Equator at 300 fathoms only, descending from a surface temperature of 75° F. The reason for this has been already shown to be the continual rise of the Polar under-flow towards the surface in the Equatorial belt. A further confirmation of these views is obtained from a comparison of specific gravities. The density (due to salinity) of surface-water increases from the poles to the tropics, while that of bottom-water in the tropics is nearly the same as in the polar area. Why then does the bottom-water of the tropics, being of lower salinity, underlie the more saline strata? Because the density it lacks from its lower salinity is more than compensated by the lowness of its temperature. Passing, however, from either tropic towards the Equator, the salinity of surface-water is found to diminish, until its specific gravity is reduced from 1027·3 to 1026·4 or 1026·3, which is that of the polar under-flow. Lenz adduced the low salinity of the surface-water under the Equator as evidence of the rise of polar water from the bottom, and showed that there is a band of water at the Equator colder than any to the north or south of it.

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* Geological Magazine.—The substance of a lecture delivered before the Geologists' Association, on December 4th, 1874.

The Oceanic Circulation thus produced brings every drop of water in turn to the surface, enabling it to part with carbonic acid and to absorb oxygen; this, then, is its importance to Animal Life. From the analysis of gases dissolved in the water of the oceanic area, it was found that, for 45 per cent. of carbonic acid there was usually from 16 to 20 per cent. of oxygen—this being the result of a series of observations taken off Ireland and Scotland at various depths down to 2000 fathoms. This amount of oxygen is sufficient to support a large quantity of Animal Life, in spite of the, to air-breathers, fatal proportion of carbonic acid—if indeed the carbonic acid be not in a liquefied, and thus perhaps more innocuous form.

In the Mediterranean totally different conditions prevail. It was expected that a Tertiary fauna would be found at great depths, analogous to the Cretaceous-like fauna of the ocean outside. Instead of that, only a viscid mud, almost devoid of life, was brought up. The western basin has a depth of 1600 fathoms, the eastern basin one of 2000 fathoms; the bottom temperature is nearly uniform at about 55° F., a great difference in thermal condition from the Atlantic. The reason is that the Mediterranean is cut off entirely from the polar under-flow, which, off Lisbon, produces a temperature of 40° F. at a depth of 700 fathoms, and 36½° at 1500 fathoms. In the Mediterranean, on the other hand, we have a surface temperature from 60° to 70° F., which, in the first 100 fathoms, falls to 54° or 55° F., below which to the bottom, no matter at what depth, there is no change at all, but a slight variation according to latitude, due in part to the mean winter temperature of the locality. The whole of the lower portion, therefore, below the influence of the Gibraltar current, is a mere stagnant pool; and this is the explanation of the absence of Animal Life except in the shallows. The impalpable mud, which is slowly settling to the bottom, may also not be without its effect. This is the result of the attrition of soft Tertiary shores, and of the clay brought down by the Rhone into the western basin, and by the Nile into the eastern, the finer particles pervading the entire sea. Corals and Bivalves suffer from it especially. The per-centage of carbonic acid was found to be as high as 60, whilst that of oxygen was only 5; this is believed to be due to the organic matter, brought down by the rivers, using up the oxygen. These unfavourable conditions are primarily due to deprivation of the general oceanic circulation. which maintains life at such great depths.

There seems, however, to be a limit, in respect of depth, to the preservation of animal remains; due possibly, as conjectured by Prof. Thomson, to the solvent power of sea-water at pressures below 2200 fathoms. This may serve to explain the passage of true *Globigerina* ooze, first into grey ooze, poorer in calcareous matter, and finally at great depths into red ooze devoid of lime. Moreover, this dissolving of calcareous skeletons at great depths may serve to explain the production of Greensands, such as is now going on along the line of the Agulhas current. These consist largely of the internal casts of foraminifera, the sarcode of which has been replaced by glauconite. The importance of such facts to geologists is immense. It was the examination of a series of casts of similar bodies in a green sillicate, that, years ago, formed the foundation for the lecturer's interpretation of the structure of Eozoön, where there is a replacement of its sarcodic body by a green silicate, viz. serpentine. If the sea-water, under this tremendous pressure, has dissolved away the shells of Foraminifera, after their sarcode has undergone the substitution alluded to, a beautiful application of this kind of research to geological phenomena has been brought forward.

Referring to Ed. Forbes's limitation of marine life to 300 fathoms, the lecturer observed that the statement was true of the Ægean, as of the whole of the Mediterranean, where there is abundant life in the littoral zone, diminishing rapidly towards 250 fathoms, below which Animal Life is almost at zero. Finally it is not a limit of pressure, of heat, or even of food, but the limit of oxygenation, as determined by the presence or absence of a thermal circulation, which affects the life of animals.

So that deposits forming in inland seas, excepting in the shallower portions, we must expect to be destitute of fossils. This is well illustrated by the Miocene strata of Malta, where certain coarsish beds, representing shallow water conditions, are full of fossils in a fine state of preservation; whilst the very fine building stone, corresponding closely with the finest calcareous deposit of the Mediterranean, contains hardly any remains but such as would fall in from above, *e.g.* the teeth of sharks. This may explain the paucity of fossils in many strata, especially in the Red Sandstones of inland seas. Much depends upon the depth of the communication, supposing there to be one with the oceanic circulation; and the level of this may be often inferred from a knowledge of the line of permanent temperature of such inland sea. To the general paucity of animal life under such conditions the Red Sea appears to be an exception, notwithstanding the shallowness of the Straits of Babelmandel. This is probably due to the absence of the sediment and oxidating matter of large rivers, and to the rocky nature of its shores, conditions which insure a clear water: whilst a certain circulation, producing oxygenation, is kept up to supply the enormous evaporation, which, if the Straits were closed, would desiccate the basin in three or four hundred years.

MISCELLANEOUS.

New Coal Fields in Russia.—The practical advantages of Geology are well shown in the discovery of new coal-fields in Russia, and in the extension of the known coal areas, far beyond the limits previously assigned to them. In the district of Tula, south of Moscow, is a coal field covering 13,000 square miles, with two seams of coal, one of three feet and the other of seven feet in thickness. On the shores of the Sea of Azoff is another field of 11,000 square miles, containing good seams of both anthracite and bituminous coal. It is reported that sixty seams have been discovered, forty-four of which are workable, having a total thickness of 114 feet. Another small coal-field has been discovered at the base of the Ural Mountains, but this is unimportant. It does not appear that any of these deposits belong to the true old coal formation. They are, nevertheless, of considerable value, and will greatly aid in the development of the mineral wealth of the Russian Empire.—*Athenæum.*

New Vegetable Remains in France.—A remarkable collection of sillicified vegetable remains has been discovered by M. Grand'Eury in two beds of conglomerate, occurring in the coal-field of St. Etienne, in the south of France. These remains consist of fossil fruit, or rather of naked seeds resembling those of the cycads or conifers. They have recently received careful study by M. A. Brongniart, who has distinguished among them no fewer than seventeen genera, represented by twenty.four species.—*Ibid.*

Warwickite.—Professor J. Lawrence Smith has recently published in the American Journal of Science an analysis of this very interesting mineral—the only borotitanate known. His results are as follows:

Boracic acid	27.80
Titanic acid	23.82
Magnesia	36.80
Oxide of iron	7.02
Silica	1.00
Alumina	2.21
	98.65

The formula for the mineral which Prof. Smith is disposed to adopt is $5\ Mg\ O\ 3\ BO_3 + (Mg\ O, Fe\ O)\ 2\ Ti\ O_2$.

Permanent Ice in a Mine in the Rocky Mountains; by R. Weiser of Georgetown, Colorado.—Geologists have been not a little perplexed with the frozen rocks found in some of our silver mines in Clear Creek Co., Colorado. I will first give a statement of the facts in the case, and then a theory for their explanation.

There is a silver mine high up on McClellan Mountain, called the "Stevens Mine." The altitude of this mine is 12,500 feet. At the depth of from 60 to 200 feet the crevice matter, consisting of silica, calcite, and ore, together with the surrounding wall-rocks, is found to be in a solid frozen mass. McClellan Mountain is one of the highest extreme spurs of the Snowy Range; it has the form of a horse-shoe, with a bold escarpment of feldspathic rock near 2000 feet high, which in some places is nearly perpendicular. The Stevens Mine is situated in the south-western bed of the great horse-shoe; it opens from the north-western. A tunnel is driven into the mountain on the lode, where the rock is almost perpendicular. Nothing unusual occurred until a distance of some 80 or 90 feet was made, and then the frozen territory was reached, and it has continued for over 200 feet. There are no indications of a thaw, summer or winter; the whole frozen territory is surrounded by hard massive rock; and the lode itself is as hard and solid as the rock. The miners being unable to excavate the frozen material by pick or drill to get out the ore (for it is a rich lode, running argentiferous galena from 5 to 1200 ounces to the ton), found the only way was to kindle a large wood fire at night against the back end of the tunnel, and thus thaw the frozen material, and in the morning take out the disintegrated ore. This has been the mode of mining for more than two years. The tunnel is over 200 feet deep, and there is no diminution of the frost; it seems to be rather increasing. There is, so far as we can see, no opening or channel through which the frost could possibly have reached such a depth from the surface. There are other mines in the vicinity in a like frozen state.

From what we know of the depth to which frost usually penetrates into the earth, it does not appear probable that it could have reached the depth of 200 feet through the solid rock in the Stevens Mine, nor even through the crevice matter of the lode, which, as we have stated, is as hard as the rock itself. The idea, then, of the frost reaching such a depth from the outside being utterly untenable, I can do no other way than fall back upon the glacial era of the Quaternary. Evidences of the glacial period are found all over the Rocky Mountains. Just above the Stevens Mine there are the remains of a moraine nearly a mile long and half a mile wide. The debris of this moraine consists of small square and angular stones, clearly showing that they have not come from any great distance; and just over the range, on the Pacific slope, there are the remains of the largest moraine I have ever seen, consisting of feldspathic boulders of immense size. I conclude, therefore, that it was during that period of intense cold that the frost penetrated so far down into these rocks; and that it has been there ever since, and bids fair to remain for a long time to come.—*Amer. Jour. Science.*

DEEP BORINGS.—The deepest boring on record is that executed by the Prussian Government engineers at Sperenberg, about 25 miles south of Berlin. The following details concerning it are from the Geological Magazine:

"The boring for the first 956 feet (983¾ English feet) was made by manual labour, at a cost of about £1600.

"Several accidents having happened, the borehole was then lined for a depth of 85 feet (87½ English feet) with tubes of 15 inches diameter; beyond that, to the depth of 100 feet (103 English feet), with 14 inch tubes; and then to 363½ feet (374 English feet) with tubes of 12½ inches diameter.

"The length of time occupied in the above-mentioned work was fifteen months, comprised between May, 1867, and July, 1868.

"From the depth of 956 feet (983¾ English feet), for the remaining distance, the boring was carried on by means of a steam engine. The length of time consumed in sinking this additional 3095 feet (3184¾ feet English), comprised between January, 1869, and the 15th September, 1871, was about 31½ months, during which interval several accidents occurred.

"The total expenditure upon the whole boring, 4051 feet (4172⅓ English feet), both by manual labour and by steam power, was about £8717 14s., making the average cost for every Prussian foot in depth about two guineas, or about £2 1s. 9d. per English foot.

"The whole time spent on the work was 51½ months; but as there was an interval of 5 months, between July, 1868, and January, 1871, during which period the boring operations were suspended, the actual number of working months becomes reduced to 46½.

"The process of boring throughout was by percussion borers worked by rods; and the rocks bored through belonged to the Triassic series.

"The progress of the work would have been much greater but for the accidents which took place, and for the delays which were caused by the observations that were made as to the increase of the temperature of the earth in depth, &c."

The next hole, as regards depth, is that executed under the direction of Mr. Charles H. Atkeson on the grounds of the St. Louis Co. Insane Asylum in Missouri. It was begun in March, 1866, and finished in August, 1869, the depth reached being 3843½ feet. The last 40 feet of the hole was through granite, but the beds above this were of the Lower Silurian and Carboniferous formations.

FAUNA OF THE MAMMOTH CAVE.—Interesting additions to our knowledge of the fauna of the Mammoth Cave have recently been made by Mr. F. W. Putnam, of Salem, U. S., who, as a special assistant on the Kentucky State Geological Survey, of which Prof. N. S. Shaler is the director, had great facilities extended by the proprietors of the cave, and he made a most thorough examination of its fauna, especially in relation to the aquatic animals. Mr. Putnam passed ten days in the cave, and by various contrivances succeeded in obtaining large collections. He was particularly fortunate in catching five specimens of a fish of which only one small individual had heretofore been known, and that was obtained several years ago from a well in Lebanon, Tennessee. This fish, which Mr. Putnam had previously described from the Lebanon specimen under the name of *Chologaster Agassizi*, is very different in its habits from the blind fishes of the cave and other subterranean streams, and is of a dark colour. It lives principally on the bottom, and is exceedingly quick in its motions. It belongs to the same family as the two species of blind fishes found in the cave. He also obtained fine specimens of four species of fishes that were in every respect identical with those of the Green River, showing that the river fish do at times enter the dark waters of the cave, and when once there apparently thrive as well as the regular inhabitants. A large number of the white blind fishes were also procured from the Mammoth Cave, and from other subterranean streams. In one stream the blind fishes were found in such a position as to show that they could go into daylight if they chose, while the fact of finding the *Chologaster* in the waters of the Mammoth Cave, where all is utter darkness, shows that animals with eyes flourish there, and is another proof that colour is not dependent on light. Mr. Putnam found the same array of facts in regard to the crawfish of the Cave, one species being white and blind, while another species had large black eyes, and was of various shades of a brown colour. A number of living specimens of all the above-mentioned inhabitants of the waters of the Cave were successfully brought to Masschusetts after having been kept in daylight for several weeks, proving that all the blind Cave animals *do not* die on being exposed to light as has been stated.—*Nature.*

OYSTERS IN GREAT SALT LAKE.—The cultivation of Oysters has been attempted by the United States Commission of Fisheries in the Great Salt Lake of Utah, where numbers of these bivalves from California have been placed with a view of testing the possibility of their thriving there. Some beds were choked by mud brought down some small mill streams, but in other parts the oysters promise to succeed. Shad have also been placed in the lake and have been seen in good health, and a lot of salmon fry from the Sacramento, artificially hatched out, have been placed in the Jordan and other rivers running into the Great Salt Lake. So far in the fresh waters they have done well, and at ten months old were from four to six inches long. It remains to be seen whether they will thrive as well in the salt waters of the lake as in the sea itself. The experiment is a most interesting one, and opens up some curious questions in the natural history of the salmon and the other fish under experiment.—*Ibid.*

BEAVERS ABROAD.—According to *Nature*, the Marquis of Bute has recently purchased eight Canadian Beavers, seven of which have arrived safely in the Island of Bute, and have been placed in the enclosure constructed for the four which died some time ago on Drumreoch Moor. They are to be supplied with food for some time to come, until they have learned to provide for themselves in their new home.

OBITUARY NOTICE.*

THE LATE MR. BRYCE M. WRIGHT.

"We regret to have to announce the death of this Cumberland gentleman, which took place a short time ago at his private residence in Great Russell St. Bloomsbury, London. Mr. Bryce Wright was well known in the scientific world, having devoted the whole of his life to the studies of Mineralogy and Geology, more particularly as applied to his native home, the Lake district. His first geological discovery was that of a curious bivalve crustacean, which, although very common in the Skiddaw slates, had not been detected by other geologists. It is remarkable for being the lowest form of crustacean known, and was named by Professor Salter in honour of its discoverer, *Caryocaris Wrightii*. Scores of fossils, through the indefatigable perseverance of this gentleman, have been brought to light, his last discovery being that of the dentigerous bird's head *Odontopteryx toliapicus*, Owen, a notice of which at the time of its discovery appeared in our columns. It was not only in palæontology that Mr. Bryce Wright made important discoveries, for in Mineralogy his discoveries were more numerous if not more important. In the Lake district alone he brought to light more than a dozen new minerals, the most important of which were *Brochantite* (a hydrous oxide of copper with sulphuric acid), *Leadhillite* (sulphato-tricarbonate of lead), *Lanarkite*, *Caledonite*, &c. In other localities (particularly Derbyshire) he was equally successful, and was the first discoverer in England of the minerals *Phosgenite* (murio-carbonate of lead), and *Matlockite* (an oxy-chloride of lead), as well as many others too numerous to mention. He seemed to possess a peculiar instinctive capacity for the detection of any new specimens of natural history, for not a single subject did he take in hand but he left the mark of his originality upon it. In the conchological world he was equally successful, and discovered many new specimens, which have been of the greatest importance to malacological science. The *Volute Ruckeri* from Australia, the *Bulimus (pseudachatina) Wrightii* from Old Calabar, *Spondylus Wrightianus* from Nicholl's Bay, as well as many other shells from all parts of the world, owe their discovery to his keen power of detection. He was a native of Hesket-new-Market, and by his rambles among the Cumberland mountains gained experience through Nature itself, which assisted him greatly in the discovery of so many specimens of natural history. He was a member of many learned bodies, and was elected a Commissioner for the Exhibition of 1862. His decease, so universally regretted, will be felt in Hasket-new-Market and Caldbeck, having been a supporter of all schools and schemes for the advancement of knowledge in those districts."

Mr. Wright was a corresponding Member of the Natural History Society of Montreal, and presented many fine specimens of minerals, fossils, shells, &c., to its Museum. Of late years he devoted much time to the study of archæology (especially in its connection with geology), and his practical acquaintance with the former science was by no means inconsiderable.

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* From the *Carlisle Patriot*, Cumberland, England.

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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

ON THE SURFACE GEOLOGY OF NEW BRUNSWICK.

By G. F. Matthew, F.G.S.

The present paper on the *second group* of surface deposits, is in continuation of one published in the *Canadian Naturalist*, New Series, Vol. 6, No. 1, and devoted to a description of the Drift striæ and Boulder clay in the Southern counties of New Brunswick. Since the former article was written, other facts having an important bearing on the geology of the Glacial period have been observed, to which I would refer, before entering upon the main subject of this one.

I. Glacial Epoch.

A careful examination of the direction of the striæ recorded in the table given in my previous article, shows clearly the influence of the contour of the land, even in minute particulars, upon the course of the glacial striæ. I have had an opportunity, during the past summer, of verifying this feature in the action of the striating force; and have observed that the later striæ conform more closely to the minute inequalities of the surface than do the more ancient markings. It is also a general rule that the older courses of glacial lines are much heavier than the later, though not so distinct nor so sharply cut. The greater prominence of the later striæ is due to the obliteration to a greater or less degree of the older set, for the latter are often to be seen only on certain protected slopes of the ledges. In addition to the secondary or distinct set of striæ,—in which is included the great majority of those recorded in the following table—there is not infrequently a third group of lines, lighter and more irregular than the last, and still more obviously affected by the contour of the surfaces over which they are spread. Such variations might naturally be looked for as likely to result from progressive diminution in the thickness of the ice cap, as the maximum of density and volume gradually receded to the North.

As an instance of these variations, the striæ under No. 39 of the following table may be cited. This ledge has been uncovered in taking gravel for road-making, and the glacial markings are fresh and sharply cut. The oldest record on the ledge shows that the ice once moved directly, through Beaver Harbour, in a course nearly due South, scoring horizontally the slopes of the ridges by which it is bounded on either side. This southerly direction is that of the striæ on the highest ridges in the Southern counties. The course of the next set of lines shews a tendency in the ice to slide obliquely downward into the harbor; and finally it appears to have moved directly down off the hill into the basin in front. The bearings on this ledge exhibit a change in the course of the moving ice, from first to last, of fully a quarter of a circle. Similar influences may be traced in the striæ of Bocabec Bay, and in the converging lines which enter the upper basin of L'Etang River.

Perhaps the most remarkable locality for these markings is one observed by Prof. L. W. Bailey, last summer, on the west side of Chamcook Mountain, near Saint Andrews (No. 12). This eminence (637 feet high) has on its western side a buttress or lower hill, which overlooks the Sainte Croix valley. The rock is steep and high, and toward its base there is a deep recess cut in the face of the cliff, and extending for some distance along its foot. The ledge which covers the recess overhangs about *sixty degrees!* and upon its under-surface are strong, regular, and distinct striæ, parallel to the direction of the cliff. Below this overhanging rock there is a *talus* of loose blocks of felsite, extending to the base of the hill—about seventy feet lower—where the ground becomes nearly flat, and descends gradually to the Sainte Croix River. For a space of four miles to the west, and an indefinite distance to the south, there are no elevations or ridges which could have brought pressure upon the under-surface of this overhanging rock to groove it; and it was protected from the assaults of icebergs by an extension of the Chamcook range of hills for three miles to the north-west. Here, therefore, if anywhere, the glacier has left a witness of its former presence in New Brunswick.

SECOND TABLE OF STRIÆ IN SOUTHERN NEW BRUNSWICK.

[These notes are arranged according to the longitude of the places mentioned, from West to East; and, as in the former table, the courses are corrected to the true meridian. I am indebted to Prof. L. W. Bailey for those marked with an asterisk (*); and Mr. R. W. Ells has added those indicated by an obelisk (†).]

No.	Description of the Locality.	Exposure.	Course.
1	Prince William, on E. & N. A. R.R., 3 miles S.W. of McAdam Junction..........	S. (flat)	S. 45° E.
2	Saint David's, Oak Bay, E. side of, opposite S. end of Rogers' Island............	W.	S. 45° E.
3	Manners-Sutton, S. end of ridge running N.W. from N. end of Oromocto L.! Latest striæ S. 60° E. and S. 40° E..	S.W.	S. 20° E.
4	" Harvey Settlement, road to Lester's Mill. Latest striæ S. 45° E. and S. 55° E........................	E.	S. 20° E. S. 10° E.
5	" Harvey Settlement, Chapel in. Latest striæ S. 45° E. (few)	S. (flat)	S. 20° E.
6	" Cork Settlement Ridge, one mile N. of Cork Station, valley in front trending E. Latest striæ S. 20° E. (few).	E.	S. 30° E.
7	" Cork Station (foot of Cork Sett. Ridge)	S.W.	S. 20° E.
8	Dumbarton, Wicher Ridge, South slope ..	S.W.	S. 60° E.
9	Saint Croix, Bradford's Cove on St. Croix R. Latest striæ S. 10° E..........	N. (flat)	S. 40° E.
10	" Southward on same shore. Latest striæ S. 30° E.....................	flat	S. 10° E.
11	" Shore of St. Croix R., opposite Doucet Island. Latest striæ S. 20° E......	flat	S. 5° E.
* 12	" Chamcook Mt., W. end of, on a cliff overhanging about 60°	W.	S. 10° E.
13	" Chamcook Lake, E. shore of, on E. side of a ledge that overhangs 20°. Striæ converge from N.W. on overhanging face	E.	S. 50° E.
14	" Chamcook L., near outlet. High hill on E. and N.E.; flat and open to southward. Older striæ S. 45° E...	W.	S. 25° E.
* 15	Pembroke (Maine), W. branch of river...	S.W. (flat)	S. 50° E.
16	Saint Andrews, Chamcook Cove, E. side. Older striæ S. 50° E...............	S.W.	S. 10° E.
17	Eastport (Maine), Broad Cove, *roche moutonné* ledge, descending to......... On N.E. slope striæ S. 60° E, on N.W. slope	N.	S. 55° E.
18	Saint Patrick, Bocabec Bay, head of. Oldest striæ S. 40° E.; latest S. 10° E.....	S.W. (flat)	S. 20° E.
19	" Near the last (projecting ledge to N.)..	flat	N. 70° E.
20	" Bocabec Bay, end of a low point on E. side of. First striæ S. 40° E.; last S. 5° E......................... (last striæ on N. side of same ledge, S.)	W.N.W.	S. 20° E
21	" Bocabec L., N. side of. Last striæ S. 35° E...........................	S.W.	S. 25° E.

No.	Description of the Locality.	Exposure.	Course.
22	Saint Patrick, Duncan Road, 1¾ mile N. from Turner's Mill................	N.E.	S. 25° E.
23	" Digdeguash Valley, near N. end of Duncan road. Last striæ N. 70° E. !	E.	S. 30° E.
24	" Digdeguash Basin, in deep narrow valley (course S.) W. of mill at.......		S. 30° E.
* 25	West Isles, Pendleton's Isl'd, N.E. end of	S.W.	S. 65° E.
26	Saint George, Hill betw'n Piskahegan and Magaguadavic Rivers, N. slope of...	W.	S. 60° E.
27	" Magaguadavic Harbour, Creek S. of...	N.W.	S. 85° E.
28	" Fork of Back-Bay Road, near E. end of LaTête ridge..................	N.W.	S. 50° E.
29	" LaTête Harbour, head of Back Bay, S. side of a swale near road. Last striæ S. 75° E.....................	N.W.	S. 25° E.
30	" L'Etang R., N.W. side of basin at head of. Later striæ S. 80° E............	N.E.	S. 60° E.
31	" L'Etang R., S.W. side of same basin. Later striæ E !....................	W.N.W.	S. 60° E.
32	Pennfield, L'Etang R., E. side of same basin	S.	S. 15° E.
33	" L'Etang R., on ridge S.E. of same basin	N.W.	S. 5° E.
34	" " S. slope of this (N.E.—S.W.) ridge......................	S.	S. 5° E.
35	" " next ridge going south. Later striæ S. 20° E...............	N.W.	S. 25° E.
36	" L'Etang R., on E. side of Narrows, (high hill on W. side of the river)..	N.	S. 60° E.
37	" Black's Harb., N. of clay flat on r'd from	S. (flat)	S. 60° E.
38	" Beaver Harb., head of, at tide level, high ridge to S. Older striæ S. 30° E.	N.	S. 60° E.
39	" Beaver Harb., same ridge, S.E. slope of. on a *roche moutonné* ledge, 4x10x30 ft. Oldest striæ S. 10° W.; last striæ S. 80° E.; chief striæ S. 30° E., curv'g to On N. side of ledge are a few last striæ S. 20° E.....................	(S.E.)	S. 40° E.
40	Blissville, Fredericton Junc., E.&N.A.R.R. on ridge one mile S. of..............	N.N.W.	S. 5° E.
41	" Forks of Fredericton and Clones roads.	N.N.E.	S. 25° E.
42	Petersville, Fredericton road, E. side of Stony ridge......................	N.E.	S. 20° E.
43	" Parish Church, Headline Hill—valleys to N.W., W., and S...		S. 35° E.
† 44	" Olinville Plateau		S. 60° E.
45	Gagetown, Clones, Wilson road. Oldest striæ, S. 35° E. Chief striæ, S. 45° E curving to......................	(S.W.)	S. 40° E.
46	Hampstead, E., of Blue Mt. on slope to Long Lake.......................	N.E.	S. 35° E.
47	Lancaster, South Bay Station E.&N.A.R.R. Oldest striæ, S. 10° W.; last S. 15° E.	N.E.	S. 5° E.
† 48	Northfield, Newcastle R., above Yeoman's Bridge......	N.	S. 15° W.

Abyss in the Bay of Fundy.—Finding that the drift striæ along the coast of the Bay of Fundy, in the western part of Charlotte county, did not conform to the course of the rocky ridges, but crossed them at right angles, I was led to examine the contour lines of the bottom of the Bay. Elsewhere, along the New Brunswick shore, the water deepens gradually; but south-east of the islands which shelter and shut off Passamaquoddy Bay, and extending thence along the eastern side of Grand Manan to Briar Island in Nova Scotia, there is a remarkable gulf, in all parts of which the sounding line goes down more than a hundred fathoms. A tongue of deep water extends from it toward La Tête Passage, and other tongues point up the Bay of Fundy. The deeper part of the gulf (enclosed by the 100 fathom contour line) is much wider near the Nova Scotian shore, where also the descent to deep water is very abrupt—especially at the North-west Ledge off Briar Island, where the bottom sinks down to the depth of 100 fathoms, at the distance of a mile and a-half from the shore.

This deep cavity has evidently exercised a controlling influence on the glacier which passed over Passamaquoddy Bay and L'Etang Harbour; for the striæ shew a decided convergence toward it from the land to the W., N.W. and N. of it. This movement was analogous to that referred to in my previous article on Surface Geology, as exhibited by the striæ of Nos. 46, and 47, as compared with 45, 48, 49, 50 and 52 in St. John county.

[I have assumed that the abyss in the Bay of Fundy existed in the Glacial epoch; for without adducing proof that the level of the adjoining land has not been greatly changed since that period, there are strong reasons for supposing that this depression was formed in the Triassic period. It is well known that the whole northern coast of Nova Scotia, as far east as Cape Blomidon, is bordered by a range of volcanic hills of that period; and it has been suspected that the trap rocks of Grand Manan are of the same age. This surmise was confirmed during the exploration of that island undertaken by Prof. Bailey, a few years ago, for the Geological Survey of Canada. Grand Manan is the only part of New Brunswick where any considerable mass of Triassic trap has been found, and the deep submarine trench along its eastern shore would appear to have resulted from the simultaneous action of volcanic forces in New Brunswick and

Nova Scotia, causing the collapse of the earth's crust in the intermediate space. For the same reason, probably, deep water surrounds Isle Haute, an isolated peak of Triassic trap in the Bay of Fundy, toward its upper end: and it is noteworthy that wherever in this part of the Bay, Triassic trap appears upon two opposite shores, holes and troughs exist in the intervening space in the bottom of the Bay. I may add that the regular trend across the bay of the contour lines of 50, 40, 30 and 25 fathoms, toward that part of the Nova Scotian coast where the trap mountains attain their greatest development, is not without significance in this connection.]

II. Syrtensian Epoch.

Under this head I propose to describe a group of beds which rests immediately on the Boulder clay: in the flat country of the interior, they are largely composed of sand, but in the valleys among the Southern hills, and between the ridges of slate in the northern part of Charlotte county, much coarse material is mingled with the sand, and in narrow and confined valleys the deposit is apt to consist chiefly of gravel and to contain great numbers of blocks of stone, and boulders more or less rounded and deprived of striæ. Either these beds are not well developed in other parts of Canada and along the Atlantic seaboard, or their position and origin has been misunderstood. Prof. C. H. Hitchcock includes similar beds with the Leda-clay in his division of the Drift which he calls the Beach and Sea-bottom period, but in this country the known beaches are associated with a later group (Saxicava sand) and his Sea-bottom beds seem to correspond to the Leda-Clay. The gravelly group is not recognized by Dr. Dawson apart from the Leda-clay, probably because it forms but an inconspicuous portion of the Modified Drift in the Saint Lawrence valley. I think, however, that it is recognizable in some of his sections, as for instance that of the Glen brick works, Montreal, Nos. 8, 9, 10 and 11 of the Section.* Also in speaking of the stratified sand and gravel of Nova Scotia,† which he considers to be "newer than the Boulder-clay, and also newer than the stratified marine clays," he describes strata very like our Syrtensian beds.

Dr. A. S. Packard gives sections of some Post-pliocene depo-

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* Notes on the Post-Pliocene Geology of Canada, Montreal, 1872.

† Op. cit. pp. 39 & 40.

sits on the coast of Maine * from which—as for instance that of Gardiner (page 244)—it appears that gravel beds like those of the surface deposits in New Brunswick lie at the base of the Modified Drift in that state. In his description of the Eastern Coast of Labrador there are passages which forcibly call to mind the probable condition of our own province when these Syrtensian beds were forming. Speaking of the present condition of this desolate shore he says:—" It is an important fact that the " present contour of the coast from the sea level to a height of " about 500 feet, also extends to at least 50 fathoms, or 300 " feet below the surface of the water. Such we found to be the " fact in dredging for a distance of nearly 600 miles along the " coast. . . . . . . Again, dredging was carried on off " Henley Harbour (Northern entrance to the Strait of Bellisle) " on a pebbly bottom 300 feet below the surface which formed " the continuation of the same beaches which rose some 200 " feet above the sea level. . . . . . . At the settlement " in Chateau Bay is a remarkably steep beach which ascends " halfway up the side of the hill which is about 500 feet high. " It is composed of very large boulders closely packed in layers, " without any gravel to fill up the interstices, and slopes to the " level of the water at an angle of at least 40°, being the steep" est beach I saw on the coast. . . . .
" This beach, when below the level of the sea, was evidently ex" posed to the action of the powerful Labrador current which " piled these huge water-worn rocks in a compact mass which " served to resist the waves, while the coarse gravel and sand " were borne rapidly away further out to sea on to lower levels."

This thorough sorting out of all the mud and fine sediment by the action of the Arctic current on the coast of Labrador, is but a continuance further north of the powerful agencies once at work in our own province. I have said that over much of the open plain in the interior of New Brunswick the beds which rest immediately upon the Boulder-clay are sandy, and they are there for the most part concealed by beds of Leda-clay: but on proceeding southward and entering the Southern hills, where the valleys are deep and narrow, the cutting power of the current was brought into active play, and gravel ridges and slopes became quite common, and are often a marked feature in the landscape.

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* On the Glacial Phenomena of Labrador and Maine, Memoirs of Boston Society of Natural History, Vol. 1, Part 3.

According to their relation to the neighboring eminences, and to the straits and gorges between them, these (now elevated) shoals take varying forms—forms of which there are four principal types, viz.—1st. The *Weather Shoal*. This has been cast down before a hill, or on one or both sides of the entrance to some gorge: it has usually a rounded form sloping gently downward to the plain in front, and often having a hollow behind it, separating it from the solid rock of the hillside. Gravel knolls of this nature may be seen at the falls of the Piskahegan River, Charlotte county, and at the gorge leading from the valley in the S. W. corner of Sussex parish in Kings county to that of the Hammond River.

2d. The *Lee-Shoal*. This has gathered behind hills or the outlets from gorges. Ridges of this kind are quite numerous.

3d. The *Centre-Shoal*. This is an accumulation of gravelly materials formed in the open space beyond a gorge or upon the top and slopes of rocky ridges, either covered with or partly denuded of Boulder-clay. "*Giant Graves*" and *Whale-backs* are of this group: the former being for the most part gravel throughout their whole depth, and comparatively small; the latter having usually a substratum of Boulder-clay.

4th. *Horseback*, Boarsback or Escar. This type of gravel bank usually extends along the top of rounded slate ridges, forming a crest often many miles in length, or it forms a connecting bank between neighboring rocky hills. These long and uniform ridges appear to have been formed at the contact of two branches of the polar current, moving side by side but with different velocities, thus giving, especially in the shallower water at the top of the ridge where their edges meet, the effect of an eddy. There is an endless variety of intermediate forms connecting the four types of gravel ridges, but they are all evidently due to the varied action of the current, now stopped by an opposing hill, and anon rushing swiftly through some gorge and scouring it out to the rocky bottom; or again, at a sudden bend of the valley, rising out of it to course across the adjoining submerged ridges.

To show at a glance the most characteristic of the gravel-ridges the following table—in which all the bearings are corrected to the true meridian—is added. When two bearings are given the first is that of the northern end of a ridge. One ridge observed by Prof. L. W. Bailey is marked with an asterisk, and those seen by Mr. R. W. Ells by an obelisk.

TABLE OF GRAVEL RIDGES IN SOUTHERN NEW BRUNSWICK.

No.	DESCRIPTION OF THE LOCALITY.	Kind of Ridge.	Length in miles	Direction.
1	Prince William, 1 mile S.W. from McAdam Junction, at E. end of a granite ridge...	Crescent-shap'd lee shoals and whalebacks.	– –	S. 50° E.
2	Saint James, St. Croix R., W. side of, extend'g from Little Simsquich to Kean's	Horseback, (two courses)	$1\frac{3}{4}$	S. 30° E. S. 20° E.
3	Saint James, E of Canous R., on high land at upper end of Lynnfield Road........	Horseback.	– –	S. 40° E.
4	" On road to Oak Hill, separating Cranberry L. from the sources of Moannes stream, a ridge in two parts separated by a hollow running S..	Whaleback and Horseback.	$1\frac{3}{4}$	S. 50° E. S. 45° E.
5	" On Road to Basswood Ridge, 3 miles south of the last...	A sharp whaleback.	$1\frac{3}{4}$	S. 45° E. S. 25° E.
6	Saint Patrick, valley of the Digdeguash R., a series of gravel knolls and ridges...	Giant's graves, whaleback, weather shoal.	$2\frac{1}{2}$	S. 40° E.
7	" Clarence Ridge, mostly Boulder clay...............	Whaleback.	$2\frac{1}{2}$	S. 35° E.
8	" Morrison Ridge, S.of the last	do.	$1\frac{1}{2}$	S. 40° E.
9	" A lower and flatter ridge S.W. of last, and mostly Boulder clay	do.	$1\frac{1}{2}$	S. 30° E.
10	" W. of Bocabec L., flat topped	Gravel ridge.	1	S. 40° E.
11	Saint George, valley of Magaguadavic, between Pomeroy Bridge and Piskahegan R...	Succession of gravel ridges.	1	about S. 40° E.
12	" L. Eutopia, S. of (parallel but less continuous ridges N. and S. of these)	Whaleback and weather shoal.	$1\frac{1}{2}$	S. 40° W. S. 50° W.
† 13	" Clarenton, S.W. corner, E. of McDougall L...........	Horseback.	$1\frac{1}{2}$	S. 30° E.
14	Pennfield, below Cripp's mill—stream on r'd to Black's Har.	Giant's grave.	– –	W.
† 15	" From S. end of Clear L., along W.side of Popologan R	Horseback.	2	S. 30° E.
16	" S.E. face of Pennfield Ridge S. do. do do.	Gravel plateau.	$2\frac{1}{2}$ $\frac{3}{4}$	S. 65° W. S. 80° W.
17	Lancaster, Musquash R., W. of, on Post-r'd to Lepreau, a flat	Gravel ridge.	$\frac{3}{4}$	S. 45° W.
18	" S. of Musquash Marsh (E. of last).....................	Whaleback.	$1\frac{1}{2}$	S. 55° W.
19	" Musquash Harb., W. of the Narrows	do.	$1\frac{1}{4}$	S. 60° W.
20	" Pisarinco, ridge ending at Negro Head.......flattened	Gravel ridge.	– –	S. 60° W.
21	" Manawagonish, long't reach of the raised beach on the Post-road to Musquash	Flattened horseback.	$1\frac{1}{2}$	S. 50° W.
22	Simonds, Mt. Prospect, top of,	Whaleback.	$\frac{1}{2}$	about S.W. (?)
23	Hammond, crossing Ham'd R. valley above Upham village.	Horseback.	1	?

General set of Polar current over New Brunswick and Maine.

In the region to which this table relates there are three tracts each characterized by certain peculiarites in the gravel ridges. In the middle tract—which includes the Oromocto Valley and Nerepis Valley—the ridges are short and irregular, owing to the course of the current which here ran obliquely to the direction of the hill ranges; and no ridges are recorded in the table, because they have not so evident a bearing on the general course of the current as the ridges in the other two districts have. In the latter the gravel ridges are much longer and more conspicuous, and approximate in direction to the course of the rocky ridges: but while in the western tract they are directed to the S. E., in the eastern they point to the S. W. They differ also in the kind of ridge which prevails; for while *horsebacks* are numerous in the western district, broader and rounder ridges, *whalebacks*, etc., are common in the eastern, and in the middle tract the gravel banks consist almost exclusively of *lee and weather shoals.*

It will be seen that the western area corresponds quite nearly to the "first tract" of glacial striæ (see page 11 of my former article) and in it the striæ agree in direction with the Syrtensian ridges; but in the eastern district near the coast there is a striking difference between the course of the striæ and the gravel ridges, the two running nearly at right angles to each other. From this it may be inferred that the hills of Southern New Brunswick which during a preceding period formed no serious obstacle to the onward progress of the Glacial ice, had risen sufficiently during the Syrtensian epoch to act as a barrier which turned aside to the right and left the principal volume of the polar current. As a result the minor currents traversing the gaps in these hills in Queen's and King's counties united with the grand current in the Bay of Fundy, and ran along the southern side of the granite hills which extend from Bald Mt. on the St. John River to Red Rock Mt. on the Magaguadavic. This would give to the sea of the Syrtensian period a depth along this coast of from 700 to 1000 feet greater than it has at present. While this may have been the depth in southern New Brunswick, when the principal gravel ridges were in process of formation, indications that the sea bottom underwent important oscillations elsewhere are not wanting. At the lower end of Lake Eutopia, near St. George, in Charlotte county, are N.E.—S.W. gravel ridges extending across a somewhat sunken tract, which has been sheltered from the rush of ocean waters down the Maga'davic valley by the granite hills enclosing the upper end of the lake. On each side of this knot of hills, but especially to the east, gravel slopes and flats have been carried out by the polar current running through the Maga'davic valley, in such a way as to indicate that the S.W. set of the current in the Bay of Fundy was overpowered in this neighborhood by the S. E. current coming through the hills to the North. A similar change in the direction of the current would seem to have taken place at Saint John, for while the course of the later gravel ridges west of that city (at South Bay) is S. 25° W. the older ones point S. 50° W.

This forcing of the current across the Southern Hills of New Brunswick in the latter part of the Syrtensian epoch may have been due to the rise of a submarine barrier at the head of the Bay of Fundy, then a broad strait, diminishing the power of the current running through that passage. Or it may have been occasioned by elevation of the sea-bottom of that period along some meridian west of the Penobscot River in Maine. From Prof. C. H. Hitchcock's report on the Geology of Maine it appears that a N. to S. course marks the gravel ridges in the valley of that river and in the southern part of Aroostook county. In the lower part of the Penobscot valley the ridges tend slightly to the west, conforming to the course of the valley; and I infer from the direction of the roads and streams in Washington·county, that the courses of such ridges there approximate to the S. E. course of similar gravel banks and ridges on our own side of the border. There was thus a convergence of the waters of the Polar current (as marked by the Syrtensian ridges) from the centre and western part of New Brunswick toward the mouth of the Bay of Fundy; and apparently a fan-like spreading of the same waters over the high wilderness tract extending through Hancock county, Maine, to Mt. Desert. It may therefore be inferred that as far West as the Penobscot valley this current was turned out of its natural S. W. course and compelled to go S. or S. E.

From other data, collected by Prof. Hitchcock in Maine, it would appear that this barrier was still further west—beyond the valley of the Kennebec River. For it will be observed that the axes of the lake basins and harbours in the maritime tract between these two rivers (the Penobscot and Kennebec) and as far as Portland, have a direction not far from 20 degrees west of south. In this they correspond to the gravel ridges of the lower part of the Penobscot valley. Now these fiord-like harbours and the lake basins cannot have been made by glaciers; for in the report quoted* there is a record of twenty or more courses of glacial striæ, in Penobscot, Waldo, Knox, Lincoln, Kennebec, Sagadahoc and Cumberland counties, which run, on the average, S. 30° E. They therefore crossed these harbours and lakes at right angles. But if it be admitted that these hollows were produced, as were similar troughs on the New Brunswick coast, by the scouring action of the polar current, there is reason to suppose that even as far west as Portland this current was compelled to seek a passage tropic-ward, in a less westerly direction than it would have done, had no barrier been interposed. This obstacle to its flow was probably the White Mountains and connected ridges to the northward of that group of hills.

Typical Localities of Syrtensian Ridges in Southern New Brunswick.

To shew the varied influence of the current in the south-western part of New Brunswick, I add here a brief description of some easily accessible localities near the coast.

Digdeguash River.—On the northern side of the range of hills through which this stream winds its way before entering the sea, there is a valley about two miles wide and seven long, across which runs, in an oblique line, a series of gravel mounds and ridges. They begin in a bank of gravel of the Lee-shoal type, cast down behind the western entrance of the basin on its northern side, near Falls Brook. To this bank succeed a number of mounds of the form known as "giant's graves," one of which is now used as a grave-yard for the church in St. Patrick's parish. These mounds extend along the flat bottom of the valley, in the direction of a large gravel ridge of a rhombic form lying in the middle of the valley. At the mound below that on which the tombstones are seen, and at the large rhombic mound, there are gravel pits in which the Leda-clay beds which fill the bottom of the valley may be seen, rising up on the lower slopes of the gravel ridges. On the flat top of the rhombic mound are two depressions, lined with a clayey soil: of these the more easterly and smaller one has a pervious bottom, and the soil is only a heavy loam; but in the other the Leda-clay covering is sufficiently thick and fine to hold a small pond of water. This large mound is, in its turn, connected by other sharp, oval mounds of the "grave" type, with a long gravel ridge extending from the river bank up against the shoulder of a granite hill on the south side of the valley: this ridge consists of two parts imperfectly divided, that part near the river approximating to the whale-back form, and the portion next the hill being a weather-shoal, with the inner end turned down along the flank of the granite hill.

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* Sixth Report on Agriculture, &c., of Maine, p. 260; and Second Report on Natural History and Geology of Maine, p. 378.

Taken as a whole, this series of knolls and ridges may be regarded as a horse-back built up between currents of different velocities—with this peculiarity, that while at the upper end of the basin the western current was the stronger, at the lower part the eastern current, having a freer outlet, by two gorges through the hills, became accelerated, and drew a part of the western current across the horse-back, cutting it into a number of detached mounds.

The course of this line of gravel knolls across the valley shews that the ocean current which formed them, pursued its southward path almost irrespective of the hills which separate this basin from Passamaquoddy Bay: and as these eminences are as much as 400 feet above the sea, it is clear that the current itself must have covered them to the depth of several hundred feet more; and thus its surface would have been quite 700 feet higher than the present sea-level.

Lake Eutopia.—This sheet of water, which discharges by Maga'davic River, is separated from L'Etang River by a gravel ridge only. The ridge is a compound one, consisting, in its western part, of a weather shoal, resting against a slate ridge, and in its eastern part of a whale-back or central shoal—the two being separated by a shallow depression, due to a light current, which drew across the ridge from the side on which the lake lies. At this locality there are clear indications that the force originating the Drift striæ was quite independent of that which threw up the Syrtensian ridges. The centre-shoal begins back of Reardon's Corner, with a course S. 45° W., and terminates with a point directed S. 55° W., while the connected weather-shoal runs S. 50° W, against the slate ridge. In a hollow south of the weather-shoal, on the road along the west side of l'Etang River are the striæ (No, 30 of the table), running S. 60° E. and S. 80° E.: the course of the striæ and ridges therefore diverge at this place as much as 120 degrees.

Carleton and Lancaster.—The entire independence of the force which produced the striæ, and that to which the gravel ridges owe their origin, is also to be inferred from the relation of the striæ and ridges west of the city of Saint John. Carleton Heights, with the hills along the Narrows and Falls of the Saint John River, formed a lee, behind which several gravel ridges, more or less connected with each other, have been piled up. West of the Heights back of Carleton, a lee-shoal, much worked over by the sea, extends S. 25° W., and is slightly overlapped by a small weather-shoal jutting out from a lower hill beyond. Sandy flats back of Sand Cove separate this hill from another weather-shoal, which rises gradually to cover the rounded ridge terminating at Sheldon Point. The western end of this ridge shews a well-defined lee-shoal cut across obliquely by the sea, and exhibiting one of the most instructive sections of the surface deposits to be seen near Saint John. Toward Sheldon point the Boulder clay may be seen resting on striated ledges of Huronian rock; and succeeding the clay westward, are beds of boulders and gravel, shewing by their overlapping layers the action of a westward moving current. The swelling outline of the bank is seen to be due to the thickening of the layers on the axis of the old shoal, and the whole is covered by beds of Leda-clay with characteristic fossils.

These various gravel banks are parts of a series extending along the seashore west of St. John Harbour, and are separated from a more continuous and higher ridge to the North, by a valley filled with Leda-clay and salt-marsh accumulations. The upper part of this higher ridge which has been cut down to a nearly uniform level by the action of the sea, exhibits along its eastward face a distinct raised beach extending for many miles to the westward of Saint John. At two points where the ridge has been cut into in making excavations, the changes which it has undergone may be easily perceived. Originally there was a series of rounded ridges, not unlike those of the southern series along the shore as they now appear, but containing proportionately a much larger share of detrital matter, due to a greater retardation of the current caused by the group of gneissic hills north of Saint John and about the Narrows of the river, than that caused by Carleton Heights. In the hollows between the swelling knolls of this series of ridges, Leda-clay was subsequently deposited, which, although in a few places abounding with boulders and at exposed points sandy, is recognizable by the red color of the mud it contains; and of which in sheltered places it is entirely composed. Ridges and points of pure olive grey Syrtensian gravel project upward into the red deposit, and sometimes through it, where subsequent wave action has worn down both set of beds to a uniform level, and covered them with a sea beach several feet thick, made up of the ruins of both deposits. The size and continuity of this range of gravel knolls, now worked down to a nearly uniform level, has served to protect a third series still further north from the action of the sea. This last row of knolls is connected with the ridge on which the raised beach runs by a cross ridge at the Fredericton road, but elsewhere is separated from it by a deep marshy hollow, which may have been connected with South Bay before this third series of gravel knolls was deposited. In this series there are ridges shewing two courses, one S. 25° W. the other S. 50° W.; the latter are nearly enveloped by the former and are therefore the older. The ridges of the middle row—that upon which the beach runs—also incline greatly to the westward. With regard to either of these courses it may be observed that here, as well as at other points along the coast as far as Pennfield and Saint George, there is a wide divergence between the direction of the gravel ridges and of the glacial striæ *

Petersville. The gravel and clay cuttings along the line of the E. & N. A. Railway in this parish expose clearly the relation between the various parts of the Post-pliocene beds, and throw much light upon the conditions under which the gravel ridges were built up.

There are two gaps in the range of hills which cross this parish—the one, Douglas Valley, which is narrow and at its highest point 200 feet above the sea: the other, Nerepis valley, much broader throughout most of its length, and eroded at its summit to within 300 feet of the same level. Douglas Valley forks in its upper part, but the wider and deeper branch has no opening to the North, being separated from the wide rolling plain of Central New Brunswick by hills 600 feet in height. Yet although the western branch at its junction with the eastern is 100 feet higher, the current passing through it in the Syrtensian epoch, was not strong enough to cast the *debris* which it bore along into the lower valley, but the gravel and sand was piled up at its mouth and along the flanks of the hills to the south. The current coming over the hills to the north and sweeping through the closed valley was the more powerful of the two, and kept possession of the main channel after the two united in the lower part of Douglas Valley.

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* Compare with striæ of Nos. 32. 33. 37. 38. 39 of Table in first article on the subject.

This combined current swept a clean and deep passage through this part of Douglas valley, but was in turn arrested at the valley's mouth by a more powerful one coursing through the Nerepis Valley. Here the arrested current deposited its burthen of gravel and boulders in a triangular, flat-topped bank at Welsford station. The flat area on the top of the bank is diversified with hillocks and holes: it slopes gently to the north, the direction from which its materials came; but much more steeply on the side facing the Nerepis Valley, which is here scooped out to the sea-level. This hollowed part of the Nerepis valley extends downward for nearly three miles from the mouth of Douglas Valley, where a sudden bend and constriction again arrested the current and caused the accumulation of another mass of gravel 150 or 200 feet deep, through which the Nerepis River at a later period cut a channel to within a few feet of tide-level.

On reviewing the relation of the gravel deposits in these valleys to the configuration of the land, observing especially the way in which the banks are built up in and around the gorges by ocean waters which, to produce these results, must have passed over barriers of 400 to 600 feet in height, the conclusion can scarcely be avoided that this was the work of a deep, powerful and elastic current.

Formation of Lake Basins by the Arctic Current.

Since the Polar Current has thrown up these mounds and banks of gravel, it cannot be doubted that it formed corresponding depressions. Just northward of the gravel bank at Wellsford Station, there is a lakelet (Harcourt Lake) exemplifying in miniature hundreds of sheets of fresh water, scattered over the face of the country, which have been produced by this agency. These lake basins have been "*puddled*" *by nature*:

for in all the valleys of this region, there are deposits, varying from 20 to 50 feet in thickness, of Leda-clay, supplying an impervious lining to the hollows left by the arctic current. Such clay beds may be seen at Harcourt Lake, rising up on the slope of the gravel mound near by. By a similar covering of the lower slopes of the gravel banks at South Bay, the Saint John River is upheld, and compelled to discharge its waters through the narrow and tortuous passage terminating in Saint John Harbour. So also the Maga'davic River, but for a similar barrier, would have found its way to the sea, through Lake Utopia and the L'Etang River; for the ridge at the head of this river, described on a foregoing page, shews a clay coating at the foot of the slope on each side. Spruce Lake, near (7 miles west of) St. John, is turned eastward by a bank so low that a few feet of elevation would cause its waters to flow into Musquash Harbour: and the chain of lakes in Loch Lomond Valley, 10 miles east of Saint John, would be drained dry, but for the barrier presented by gravel banks and clay beds at its western end. Finally, the large marshy tract of barren, bog and lake, extending from Cranberry Lake to the basin of the north-west branch of Digdeguash River, is closed at one end by the gravel ridge, No. 4 of the table, and at the other by gravel banks at the mouth of the north-west Digdeguash.

These few instances are referred to, because the places are easily accessible; but I may add that where I have examined the rims of lake basins in southern New Brunswick, I have found very few examples of lakes having rims wholly of rock. In the majority of cases, the shape and position of the lake basins is more readily explicable by the theory of current erosion than by any other: as regards the rocky hollows in which they lie, the lakes, like the fiord-harbours to which I have referred in a previous article, appear to be pre-glacial; but as regards the superficial deposits, post-glacial. It would be tedious to specify instances in support of the latter conclusion; but a study of the region to which these remarks relate, with the aid of a good map, will confirm it.

Tidal Erosion in the Bay of Fundy.

In order that a comparison may be made of the effect of tidal wear in the Bay of Fundy, with the phenomena of the Syrtensian period, I give, in the following pages, the result of an examination of the soundings in various parts of that bay, as shewn in the Admiralty chart. For although an ocean current constantly setting in one direction cannot be expected to produce exactly the same result, in transporting superficial accumulations, as the tides which flow alternately up and down the Bay, the agreement is sufficiently close to illustrate the subject under consideration.

In the Bay of Fundy, the run of tide varies from 2 or 3 knots at its mouth to 7 or 8 knots (!) in the Parrsboro passage near its head. The chain of islands which separate Passamaquoddy Bay from the larger bay, presents, on a small scale, a barrier similar to that which, during the Syrtensian period, separated the ocean waters north and south of the Highlands in Southern New Brunswick. Passamaquoddy Bay has two principal outlets, viz., Quoddy River (salt) and La Tête passage. The rush of the tide through these passes causes a roaring sound which may be heard for many miles; and the whirlpools are strong enough to upset boats and careen large vessels. Both channels are full of deep holes, ledges and pointed rocks. At Quoddy River, the tide passes over barriers having only 15 fathoms at low water; yet within there is 50 fathoms in the narrowest and straightest part, and 30 fathoms where it merges into the shallower waters of Passamaquoddy Bay: in the contour of the 20 and 15 fathom lines, tidal erosion may be traced quite across the Bay, on the Robbinson shore, along which runs the channel that connects Quoddy River with the estuary of Sainte Croix River.

Opposite the La Tête passage, tidal wear on the bottom of Passamaquoddy Bay is even more conspicuous. One would naturally expect to find in this bay the channel of such an important river as the Maga'davic, the largest entering the sea between the St. John River and the United States border; yet no trace of it can be detected beyond the 5 fathom line; on the other hand, the tidal trough which begins inside Passamaquoddy Bay, with a depth of 40 fathoms, may be traced up the centre of the Bay, through the 30, 20, 15 and 10 fathom contour lines. Even the small middle passage between McMaster's and Pendleton's Islands has produced a hollow of 24 fathoms' depth, connecting with that in front of La Tête passage.

Opposite each of the main inlets into Passamaquoddy Bay, beyond the deep water, but immediately in front of these openings, there is a shoal corresponding to the "centre-shoal" described on a previous page, as produced by the ocean current of a former period. And along the straight reach of the northern shore of Deer Island, a channel has been made by the tide, such as the Arctic current produced in Syrtensian times, at many points in the southern counties, where a similar obstacle opposed its onward course.

At Saint John, like results have been produced by the flux and reflux of the tide in the narrow passage by which that river debouches into the Bay of Fundy. Although there is only six fathoms at low water on the reef which causes the rapid ("Falls") at the mouth of the river, such is the force of the current that trenches of 25 fathoms deep below the "Falls," and 33 fathoms deep above it, have been produced.

In the open parts of the Bay of Fundy, especially in its upper half, there are ridges and hollows seemingly produced by tidal erosion. Thus in the centre of the bay, between Quaco, New Brunswick, and Margaretville, Nova Scotia, there is a depression outlined by the 40-fathom contour line, nine miles long and three wide: it lies just between the points of two ridges (outlined by the 30-fathom line) which extend out from either shore. Up in Chignecto Passage also, off Cape Enragé, there is a trough scooped out by the tide, which is outlined by the 30, 25, and 20 fathom contour lines. And furher up the same arm, another, lying in the Cumberland channel, between Peck's Point and Boss Point; this trough is bounded by the 10-fathom line, and through it the tide runs at the rate of four knots an hour.

But it is in the eastern arm of the Bay of Fundy—Minas Channel and Basin—that the scouring action of the tide is most conspicuous. The curve of this arm to the east has thrown the weight of the current on the eastern shore; and there, under Cape D'Or, lies a trough outlined by the 50, 40 and 30 fathom lines, scooped out to a depth equal to that of the deepest part of the bay between St. John, N. B., and Digby, N. S.: yet in the intervening space between St. John and Cape D'or, the soundings shoal to 25 fathoms.

Passing Cape D'or and going further up, the bottom again rises to 25 fathoms, but soon sinks into another trough 40 fathoms deep. This extends to Cape Split, where a sharp barrier reef, rising to within 25 fathoms of the surface, again intercepts the tide. Surmounting this reef, the current again plunges down into a trench 50 fathoms deep, and rushes along through the Parrsboro Passage at the great velocity of 7 or 8 knots where the water is deepest; but slackening to 5 or 6 knots, where, in the more open part of the passage, the soundings rise to 30 fathoms. Here the contour lines, those of 30, 25 and 20 fathoms, take a bilobate outline, corresponding to the two arms of Minas Basin; and at 10 fathoms' depth, this line is trilobed, showing the erosive influence of the tide even in the middle of the basin: these three indentations answer to the Cornwallis, Avon, and Shubenacadie Rivers, as will be seen if the shallower contour lines be traced. A similar result of tidal erosion may be detected in Passamaquoddy Bay, where two tongues of deep water reach up from the basin in front of La Tête passage, on the contour line of 10 fathoms, to Hardwood and Hospital Islands.

Conclusions.

Before summing up the results thus far obtained, through observations made on the surface deposits of New Brunswick, it may not be out of place to call attention to the wide difference in composition, etc., between the beds, to the description of which this article has been chiefly given, and the Boulder clay.

The latter exhibits no such indications of the powerful and destructive action of ocean currents, as are everywhere impressed on the Syrtensian beds. It does not lie in stratified beds, like the latter, nor is the clay sorted out, but it still remains evenly distributed through the mass, in company with fragments of stone that show no marks of free attrition against each other. It could not have been exposed to atmospheric action during its accumulation, for, as Dr. Dawson has remarked of this deposit in the St. Lawrence valley, and as may also be seen here, pyritous minerals in the stones of the Drift clay are quite unoxidized, and the stones themselves show no evidence of aerial wear. These considerations preclude us from regarding it on the one hand as a deposit made in places open to the force and sifting action of sea water in rapid motion; and on the other, they are not favorable to the view that these clays were left exposed, on the surface of the continent, to the winds and rains, by the retreat of the glaciers. There remains, however, one explanation of their origin which, it seems to me, meets satisfactorily the conditions of this deposit, viz., that it was pushed into the sea at the submerged foot of the glacier, beneath which it was formed.

The history of the surface deposits in Acadia, so far as I have traced it, might, upon these grounds, be briefly stated as follows :—

1. *The Striæ* mark the formation of a glacial zone across the continent, facing an open sea to the south.

2. In connection with the production of striæ there followed the accumulation of ice on the southern side of this zone, causing a depression of the earth's crust, and producing the slope required to give motion to the glacier covering the Acadian plain,* causing also the *submarine* glacier-foot necessary to account for the nature of the *Boulder Clay.*

3. Recession of the glaciers to the North, consequent upon the continuous sinking of the land at their southern border. This change would result in the widening of the submerged tract, and the admission upon it of the arctic current from the north-east; and would give rise to the formation of the *Syrtensian beds* out of the Boulder clay, the finer material of which, in tracts exposed to the wear of the current, would be carried off to greater depths and more sheltered areas in the ocean.

There is one subject which should be touched upon before bringing these remarks to a close, namely, the time-value of the Syrtensian beds: how will this epoch compare, for duration, with that of the Boulder clay? The gravel and sandy strata of the former group do not present such a thick and uniform coating of detrital matter as the latter, for, although they sometimes rise into ridges of 150 feet high, this thickness is exceptional, and there are large areas where the deposit does not measure more than a score of feet in depth, and many spots which are entirely bare.

But, although the Boulder clay is, on the average, much thicker, there are some considerations which depreciate its value as a time-indicator. Previous to its formation, the eastern part of the continent appears to have been for long ages above the ocean, and the solid rocks, under the influence of a warm and probably humid climate, had been *decomposed to great depths.* In parts of Virginia and North Carolina which have not been beneath the glacier, the gneissic ledges are now softened to a depth of thirty or fifty feet; and a similar condition of the gneissic ledges in Brazil has been noticed by Profs. Agassiz and Hartt, so it may well be admitted that great moving masses of ice, like the glaciers, would have no difficult task in breaking up and pushing into the sea these softened rocks, made loose and tender by the percolating rains of untold centuries. Another cause of the rapid growth of the Boulder clay was that the period during which it was deposited was one of *subsidence*. Whatever mud was poured into the ocean, at the glacier's foot, quickly sank to the bottom in the deep and quiet waters.

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* See p. 7 of former article on Surface Geology of New Brunswick

In the next period the conditions were changed, and strong currents invaded the submerged area. In the preceding epoch, glaciers had ground down the rocks to the hard and compact heart of the ledges, so that, except in the already existing Boulder clay, there was no source from which the roving currents of the epoch could draw for the formation of a new group of beds. Of this old glacial deposit they availed themselves; but, while building up beds out of its coarser materials, they swept off and buried in the depths of the ocean the fine sand and clay. The Syrtensian period was one of *elevation*, and was therefore one of destruction of deposits, rather than of reconstruction and growth, so that the length of time which elapsed may have been much more than the thickness of its beds indicate.

This elevation of the land after the withdrawal of the glaciers, is a phenomenon which occurred in other lands, as well as this. Sir C. Lyell, in his Antiquity of Man (page 243, Philadelphia edition, 1863), adduces proof of the gradual and steady upheaval of the land in Scotland since the ice period. And Professor T. Kjerulf, in his treatise on the Striæ, Glacial formation and Terraces of Norway (Christiana, 1871), also shews that the hyperborean marine fauna was replaced by more southern forms, as the Norwegian land arose above the sea, after the retreat of the glaciers.

It will thus be seen that the theory which I have advanced to explained the conditions of the Post-pliocene deposits of Acadia, is not without support from the glacial phenomena of other lands.

NOTES ON SOME OF THE GALENA OR SULPHURET OF LEAD DEPOSITS CONNECTED WITH THE LAURENTIAN ROCKS OF ONTARIO.

By Henry G. Vennor, F. G. S.

Galena or sulphuret of lead is so often found associated with the crystalline limestones of the Laurentian, that an idea seems to prevail that, like the magnetic oxide of iron, it may specially characterize one or more of these bands. But recent investigations, while furnishing conclusive evidence that such is the case respecting the latter mineral, appear to show clearly the contrary concerning the former. The origin of these two mineral deposits is very different. The magnetic oxide of iron is now proved to exist for the greater part in the form of beds, or interstratified masses, in certain horizons of the gneiss and limestone series; and in a recent Report of the Geological Survey, I have shown that, in Frontenac and Lanark Counties, not less than three horizons of iron ore may be identified, which bear fixed relations to three seperate bands of limestone. The galena, however, does not occur in the form of sedimentary deposits, but always in true fissure veins, which traverse great areas in the Laurentian rocks. Consequently the occurrence of this ore in veins in any of the bands of limestone is merely accidental, or, in other words, is simply owing to these bands in parts of their distribution being crossed by what may correctly be designated as zones of disturbance. It is the object of the present paper to show that these zones are accompanied by great parallel breaks or fissures and displacements of the strata, which traverse the country in straight lines for great distances.

The galena deposits of Lansdowne, Storrington, Loughboro', and Bedford have been long known, and many localities in these townships where the ore has been mined, have been mentioned in the Reports of the Geological Survey. In one of these Reports, for the year 1858, Sir W. E. Logan, in referring to the galena lodes of Lansdowne and Bedford, suggests the probability of their forming a part of the same group as the lead-bearing lodes of Rossie, in St. Lawrence County, N. Y. In this conjecture he was supported by Mr. Thomas Macfarlane, who subsequently examined these lodes, and published a short paper on the Geology of Rossie. (Can. Nat. and Geol., new series, vol. 2., p. 267 et seq.) Beyond these notices, nothing has been published on this interesting and important subject. My own explorations, however, now enable me to state with a still greater degree of certainty, that all the galena lodes belong to a great belt or zone of parallel fissures, which extends not only from Rossie in New York to Bedford, but also to a great but unknown distance beyond, in a general north-westerly direction. These lodes are not of Laurentian age, as they extend up into the Potsdam and Calciferous rocks; or perhaps it would be more correct to state that they extend, at any rate, from the Calciferous, through the Potsdam, into the upturned edges of the Laurentian strata. For we have abundant evidence to prove that these latter rocks had assumed their present folded condition long before the deposition of the former, and consequently at a still greater period prior to the force or forces which have caused so extended a fissuring of strata. It is not so clear, however, whether this force acted from below upwards, or from the Calciferous downwards into the Laurentian strata. Nor is it yet determined which rock is the true source of the ores which now fill the fissures. What evidence we have on these points, however, is instructive. We find, for instance, that the lodes are, in some way or other, connected with the junction or line of contact between the Silurian and Laurentian formations. This contact may be represented, according to Mr. Alexander Murray, "by drawing a straight line from about the middle part of Loughboro' Lake across the heads of Knowlton and Beaver Lakes, to Round Lake in Belmont, a small sheet of water a little beyond Belmont Lake, and then another from Round Lake to the northern extremity of Balsam Lake......... There will, however, be several deviations from the regularity of the straight lines, occasioned by undulations in the more ancient rocks, bringing them occasionally to the surface on the south, while a number of outlying patches of the more recent formations are spread over portions of the country to the north." The junction of these two formations will be more clearly understood by consulting the large colored geological maps published by the Geological Survey of Canada, on which the Silurian is represented by the dark blue color. Along this whole line, and extending northward from it for twenty to forty miles through the Laurentian strata, there occur equidistant and parallel fissures, or great cracks, which probably extend downwards to great depths. The course of these fissures is marked by the occurrence of doleritic and feldspathic dykes, mineral-bearing veins, or where these do not occur, by the abrupt faulting of the strata at numerous points along a number of straight and parallel lines. With these are connected all of the galena veins of Rossie, Lansdowne, Storrington, Loughboro' and Bedford, as well as those in Madoc, Marmora, Tudor and Lake in Hastings County, and Belmont, Methuen, and very probably also Galway in Peterboro' County. Thus the westward extent of this great belt of fissures from Bedford cannot be less than 100 miles, and from Rossie 150 miles. In this distance they traverse a succession of strata of very varied characters, cutting alike the gneisses, schists, diorites and crystalline limestones, and at Ringwood, N. Y., the Potsdam sandstones. Of these rocks, the crystalline limestones appear to exert the most favorable influence on the lodes, as it is in these they attain their greatest proportions and yield the most ore; while in the alternating gneisses and diorites, particularly where these are of a firm texture, they not only narrow, but in many instances are filled with different minerals, such as blende, copper pyrites, mispickel, and more rarely gold, silver, and bismuth. It is this enlargement and improvement of the lodes in the limestones that has given rise to the idea already referred to, namely, that the galena characterizes certain of these bands. The change of mineral contents in lodes of the same age is an interesting and important feature in this connection, but it is one that requires much further investigation.

The direction of most of the galena veins in Lansdowne, Loughboro' and Bedford, is a little north of west and south of east, but varies from N. 85° W. to N. 15° W. In this same direction run all the lines of faulting and most of the intrusive dykes; but these last run rather by short zig-zags than in direct lines. It is an extremely difficult matter to follow out and map any one of these lines continuously through the contorted Laurentian country, but such an attempt was made, and in two special instances succeeded beyond my expectations.

While tracing a number of the faults in Loughboro' and Bedford, one was met with towards the centre of the latter township, which, from its being farther removed from the overlying mass of the Silurian, furnished more marked features by which it could be followed. This was traced by abrupt displacements of the strata, from the vicinity of Westport Village, on the Rideau, in North Crosby, through Wolf Lake, in Bedford, to Eagle and Long Lakes, in Hinchinbrooke ; thence through Horse Shoe Lake, on the Salmon River, in Kennebec, to and through Kaladar, Elzevir, Tudor and Lake townships, in all a distance of 52 miles. This line of dislocation is accompanied, in Bedford, Tudor and Lake, by numerous parallel galena lodes; in Kaladar and Lake, by lodes carrying the sulphuret of copper, and in one instance, in the last named township, by a lode containing the sulphuret of bismuth in crystalline masses of considerable size. The cupriferous lodes are invariably bounded by diorites, green slates, and chloritic schists, or dolomites, while both the galena and the bismuth are associated with limestones. It is also noticeable that in the localities where the lodes traverse the green slates and chloritic schists, the copper ore is not confined to the lodes themselves, but extends from them along the planes of bedding of both slates and schists, forming bedded cupriferous zones, which can be traced for some distance on the strike of the rocks. These zones, however, do not appear to be of economic importance, nor is the copper ore in the main lodes in sufficient quantity to be worthy of special consideration.

To the south of this first great dislocation, and about ten miles distant from it, a second and similar important break was made out, and traced for some distance in a parallel course, northward of east, towards and through Frontenac County. This runs from the south-eastern corner of Methuen township in Peterboro' County, where its position is marked by Parker's Galena mine, through Marmora, Madoc and Elzevir in Hastings County; thence through the village of Troy or Bridgewater to a position on the Salmon River in Sheffield, about nine or ten miles to the southward of where the first described fault crosses the same river in Kennebec. In this position, the correctness of this line of fault is verified by a fact recorded by Mr. Alexander Murray in his Geological Report for 1852-53, in which he states as follows: "Six miles further down (the Salmon River) it (a band of limestone) was seen below the exit of Long Lake, where it is brought in by a dislocation indicated by a coarse grained quartzo-feldspathic dyke, transverse to the stratification; the mica slate abutted against the dyke on the north-east, and the limestone on the south-west."

Beyond the Salmon River, in an eastward direction, this line of dislocation was not clearly made out, but an extension of it, in all probability, was observed to affect the strata in the northern part of the township of Loughboro', where it is again accompanied by galena lodes. The total distance from Methuen to Loughboro' is about 60 miles.

Besides galena and copper pyrites, gold, silver and mispickel occur in the veins accompanying this dislocation. In Madoc and Elzevir both the once celebrated Richardson Mine and the Barrie Mine are in close proximity to it, and it is probable that the great segregated masses of auriferous mispickel to the west of the "Huckleberry Rocks" in Marmora are due to the same agency. This point, however, requires more detailed investigation. There is little doubt existing in my own mind, that many of the auriferous lodes of Madoc and Marmora are due to the faults, and particularly so where these traverse the dolomites, slates and schists of the Hastings series of rocks. The age, therefore, of these gold deposits is probably the same as that of the galena lodes, namely, as recent, at any rate, as the Calciferous. The source, however, from which the precious metals have been derived cannot yet be satisfactorily determined. I should also notice, in this connection, the occurrence at the Richardson Mine, Madoc, of a black carbonaceous matter or bituminous substance. This was first discovered by Dr. J. Perrigo and myself, during the year 1866, and was subsequently described by Dr. Hunt, in one of his Reports, as Anthracite. This substance is undoubtedly a true part of the lode, and was deposited along with the gold; it is, however, of rare occurrence. Respecting the depth to which these lodes are ore-bearing, little can be said with certainty at present, as there are no shafts or openings deeper than 100 or 125 feet on any of them, by which this point might in a measure be tested; but from what evidence I have been enabled to gather, I agree with Sir W. E. Logan, in a statement made by him respecting the Ramsay Galena lode, that "whatever quantity of ore the lode may carry with it, there is little doubt of its great depth, a depth to which indeed no certain limit can be placed." This statement equally applies to most of the galena lodes examined by me in Frontenac, Hastings and Peterboro' Counties. As to the quantity and constancy of the mineral in these, a word or two may be said. So far, we have abundance of proof that the galena does not extend far into the Laurentian strata, although the lodes themselves undoubtedly extend downwards to great distances. In their greater depths, they would appear either to change in mineral contents or become barren; although this is another of the points which requires further investigation.

Perhaps the largest deposit of galena yet opened up is that on the third lot of the sixth concession of Ramsay. It, however, has not been worked for a number of years, and is now filled with water and debris. This lode does not belong to the same belt or group of fissures as those of Landsdowne, Loughboro' and Bedford, but it is undoubtedly of the same age. It intersects first the Calciferous, next the Potsdam, and finally the Laurentian strata in the same township; but the ore gradually lessens and finally disappears in the older rocks. The bearing of the lode is from N. 45° W. to N. 50° W. and its underlie is, as it invariably is in all the lodes and dykes of the same age, to the northward at a steep angle. It has been shafted to a depth of eight fathoms, and somewhat upwards of thirty tons of galena, averaging 80 p. c. of lead, extracted and sold. This fact has already been mentioned in one of the Reports of the Geological Survey, but I again allude to it in connection with what has just been stated respecting the diminishing of the ore in the downward course of the lode.

The Ramsay lode is accompanied by a displacement of the strata as is the case with those of Bedford and Loughboro'; which fact is particularly mentioned by Sir William Logan, in a foot note to the Geological Report, for 1858, page 51, where after referring to the galena deposits of Wisconsin and Missouri, he says: "The Ramsay ore on the contrary occurs in a true vein, filling a crack connected with a dislocation, and on a late visit to the mine, I had an opportunity of observing a clear evidence of this in one of the walls of the lode (both of which are well defined) in the parallel grooves occasioned by the grinding of the terminal edges of the strata on the opposite sides of the crack when the displacement happened." And further on again in this same Report, in referring to the age of the Ramsay lode, Sir William says: "In addition to the Calciferous sandrock the lode will intersect the Potsdam sandstone and the Laurentian areas beneath, and in this respect resemble the Rossie lodes. Little hesitation can be felt in pronouncing it to be a lode of the same age as these, and the interesting fact is now for the first time shewn, that not only these lodes, but probably all the yet known lead veins of the Laurentian rocks, are newer than at least the Calciferous formation, and possibly than some of the formations above it, thus extending considerably the area in which such veins may by looked for." I need only add that my own observations fully support the view thus taken by Sir William respecting both the character and age of these veins, and that although I have considerably added to the lineal extent of this great group of lodes and collected many further facts relative to their conditions in the Laurentian strata, I can throw but little additional light on their true origin.

As to the future prospects of the Ramsay lode, I may state that little is to be expected either in depth, or in drifting in a north-westward direction, and for two simple but potent reasons. The Calciferous and Potsdam strata, which the lode intersects, are comparatively thin outlying deposits towards the termination of the great mass of the Silurian, which extends for miles to the north-eastward and south-eastward. Consequently at a depth not exceeding 100 feet, a shaft would probably enter the Laurentian gneisses or limestones, probably the former, when the vein might be expected to become unprofitable. The same would happen in drifting on the lode in a north-westward direction, at a very short distance. The only other course then left would be its exploration in a south-eastward direction, if this be practicable, when there is no reason why the lode should not contain as much if not more ore than in the spot where it was first mined. There is perhaps, however, a possibility that higher members of the Calciferous, or immediately succeeding formations of more recent age, may cap over and conceal the lode in this direction. I cannot state decidedly that the ore in this and similar lodes would at once diminish upon entering the Laurentian, but simply that what evidence has been gathered from the condition of the lodes intersecting such strata in other localities in the same township, would point in this direction. On the other hand, the galena lodes of Rossie in St. Lawrence County, N. Y., in the Laurentian, have, to some extent at least, been profitably wrought, and many of the same through Lansdowne, Loughboro' and Bedford in similar strata, appear to be of greater or less promise. Still the fact remains that in the latter localities the lodes are no longer worked, while a number of them have been abandoned as decidedly unprofitable. The Loughboro' mine, near Indian Lake in Loughboro' township, is situated, perhaps, on one of the best tested lodes in this group, and it furnishes us with an example of how the galena may be largely replaced by blende as we descend into the Laurentian strata. In Bedford though galena was found in large masses at the surface of a number of the lodes, it beyond a doubt diminished in depth. Again, in the great series of lead-bearing veins in Tudor, Lake and Methuen in Hastings and Peterboro' Counties, astonishingly large and pure masses of ore were found in many instances immediately at the surface of the lodes, but rapidly diminished in every instance in descending. The shaft of Messrs. Hill & Kershaw in the township first named was in my opinion one of the best tests made in this section of country. It was sunk on a beautifully defined lode, cutting the grey limestone or calc schist of the Hastings series, to the depth of 130 feet, but long before reaching this depth the ore had ceased to occur in remunerative quantity, although the vein continued to descend as well defined as at the surface.

In conclusion then I can only express the opinion that these Galena lodes in the Laurentian system are merely the remnant of lodes which had their greatest development in the rocks of the Potsdam and Calciferous, both of which formations have been extensively removed by denudation.

GEOLOGICAL SKETCHES OF THE NEIGHBORHOOD OF HAMILTON.

By J. W. Spencer, Bac. App. Sc.

The country in the vicinity of Hamilton, Ontario, affords a very interesting field to the geologist. Within a limited distance there are excellent exposures of the upper members of the Medina, as well as of the Clinton, and the lower part of the Niagara formations. These reward the persevering collector with a goodly number of fossils, besides several mineral species. The superficial geology of the region in question is likewise well worthy of study.

The most prominent feature of the Western Peninsula is the Niagara Escarpment (popularly called at Hamilton "the Mountain"), which, crossing into Canada at Niagara Falls, skirts the western end of Lake Ontario, and extends northward to the Manitoulin Islands. The escarpment rises several hundred feet above Lake Ontario, sometimes forming abrupt cliffs, and at others having a more gradual ascent. At Hamilton it is about two miles from the lake, or rather from Burlington Bay, and 396 feet above the bay, or 628 feet above the sea. West of the city it recedes eight or nine miles from the bay, the north side of which it, however, again approaches, forming the valley in which Dundas is situated.

The object of this paper is to give a few facts concerning the strata composing this escarpment in the neighborhood of Hamilton, together with notes on the superficial geology, mineralogy, &c.

The Medina Formation.

This formation has only its upper members exposed at Hamilton, although at Oakville, on the north side of the lake, the lower beds are seen, being underlaid by the Hudson River rocks. The whole thickness is estimated by the Geological Survey at 614 feet, of which only about 100 feet of the upper part are seen at Hamilton, and still less at Dundas. The whole formation consists essentially of shales with some sandstones. Near the summit is the "Gray Band," a fine-grained and irregularly deposited sandstone, with a thickness at Hamilton varying between seven and fourteen feet. Above this there are eight feet of impure, slightly calcareous sandstones, in thin beds with shaly partings, and weathering in some cases to a bright red. The gray band, which is extensively quarried, forms an excellent building material, and has also been used for making grindstones.

The shales are particularly poor in fossils, nothing but a few obscure fucoids having been found in them. In the sandstones, however, a few fossils can be obtained, but it is exceedingly difficult to separate them, on account of the hardness of the rocks. Among those which I have found, may be mentioned *Arthrophycus Harlani*, *Palæophycus*, and *Lycophycus*, and of animal remains, *Lingula cuneata*, which is not rare, *Modiolopsis orthonota*, *Murchisonia notoidea* (?), and an obscure coral resembling a *Zaphrentis*. In some places rain marks are common.

THE CLINTON FORMATION.

The Clinton formation is exposed along the side of the escarpment, and having the Niagara overlying it, there are but few places where it forms the surface rock of the country. As it approaches from the east, it increases in thickness, and at Dundas is much more largely developed. It has a thickness of 78 feet at this place, consisting of thin beds of calcareo-arenaceous rocks, and some impure limestones, alternating with shales of various textures and tints. During the deposition of these strata there was a constant change in the character of the sediments, as it seldom happened that more than a few inches of the same kind of material were deposited consecutively. The sea was shallow, as is shown by ripple marking, and by quite a variety of worm tracts, as well as by the markings of rain drops. The conditions suitable to life, moreover, were more favorable than in the preceding epoch. Of the fossils obtained here, all or nearly all are likewise found in the Niagara above, and from the material collected at Hamilton it is impossible to separate palæontologically the deposits of the Clinton epoch from those of the Niagara. The Clinton, in its upward extension, has been limited by a hard dolomitic bed, which forms the base of the Niagara formation, and is sometimes known as the " Pentamerus Band."

The most curious fossils of this epoch are two or three species of *Lingula*, which are of a bright blue colour. They were first discovered in 1868, by Lieut. C. C. Grant, in the dark brown calcareo-arenaceous beds near the top of the Clinton at the "Bluff" (a cliff about a mile east of the city reservoir), and were associated with numerous specimens of *Modiolopsis*. They appeared for a time to be confined to the one locality mentioned, but recently I have found them near the city. Though bright blue when first taken out, they soon become quite dull.

Several fine varieties of *Buthotrephis gracilis*, and one or two other plant remains are found in the Clinton.

As almost all the animal remains of this formation are found in the Niagara, only a few species, that are less common above, or locally not met with there, will be enumerated, viz.—*Stenopora fibrosa*, *Heliopora fragilis*, *Trematopora fabulata*, *Clathropora frondosa*, *Ptilodictya crassa*, *Orthis lynx*, *O. Davidsoni*, *O. elegantula*, *Athyris naviformis*, *Rhynchonella neglecta*, *R. rugosa*, *Avicula emacerata*, numerous *Modiolopses*, *Cyrtodonta*, *Tentaculites distans*, *etc.* The *Lingulæ* above mentioned belong principally to *L. oblonga*, *L. oblata* and *L. cuneata*. Col. Grant has found one or two specimens of *Recepticulites*, and a few netted graptoites in the Clinton.

THE NIAGARA FORMATION.

This constitutes the upper portion of the escarpment, and extends over a considerable area, frequently cropping out through the drift. Of the rocks deposited during the Niagara epoch only 63 feet in thickness remain at Hamilton, while at Dundas the formation reaches double this thickness.

The following is a section of the Niagara Formation at Hamilton, in ascending order :

	Ft.	*Ins.*
1. Hard gray magnesian limestone, weathering yellowish, and holding *Pentamerus oblongus*, and in the lower part containing *Lingulæ*, which a few feet below in the Clinton are coloured blue....	1	6
2. Bluish, argillaceous and arenaceous shales, with some bands of arenaceous, argillaceous, or magnesian limestones.........................	21	6
3. Hard magnesian limestone with geodes of calcite, barite, selenite, gypsum, celestite, pyrite, etc.	5	0
4. Thin beds of limestone, in some cases argillaceous, separated by layers of dark bituminous shales, some of which contain graptolites..............	9	0
5. Compact magnesian limestone, known locally as the "Blue Building Beds." Some of the beds weather into pits on the surface, and are separated by shaly partings. Fossils in considerable quantities are found in these beds, especially Trilobites	14	0
6. Gray magnesian limestone, exceedingly cherty, and containing numerous remains of sponges, and reticulated graptolites in places, besides a large number of other fossils	12	0
	63 ft.	0

Although the entire thickness upward from the Pentamerus band is only 63 feet near the head of Wellington Street, it increases to the west, and near Dundas it attains to 127 feet. Eastward of Hamilton it diminishes considerably. The beds are usually irregular in thickness, the thicker bands often in a very short distance splitting up into thin layers, and rendering it impossible to identify the exactly corresponding beds, even over a limited area. Yet, by means of the Pentamerus bed it is not usually difficult to separate the base of the Niagara from the underlying Clinton. The next most noticeable bed is the third member, which is a hard dolomite, and although continuous, varying in thickness from three to six feet. This is extensively quarried, and forms an excellent building material. Some of the argillaceous limestones would doubtless make good hydraulic cement.

Fossils are not so abundant as they are farther east, where the upper beds, which are wanting at Hamilton, are developed. The two most important groups of fossils which have been recently discovered at Hamilton are sponges and reticulated graptolites; the former being found in the cherty parts of the top member of the series, while the latter are found in this as well as in the members below. The cherty beds affording the sponges thin out both to the east and west of Hamilton. Two years ago also, Col. Grant,—who discovered the graptolites three or four years since, and the sponges in 1874—obtained the bodies of certain crinoids, the presence of which had previously been recognized only by the stems or columns.

Besides several plants, some of which are not determinable, the principal fossils that can be obtained at or near Hamilton are :

Receptaculites, *Aulocopina Granti*, and other sponges not yet determined; *Favosites Gothlandica*, *Stenopora fibrosa*, *Zaprhentis Stokesi*, *Diphyphyllum*; *Dictyonema gracilis*, *D. rectiformis*, and a number of other graptolites not yet described; *Stephanocrinus angulatus*, *Caryocrinus ornatus*, *Eucalyptocrinus decorus*; three species of starfishes; *Fenestella elegans*, *F. prisca*, *Cladopora cervicornis*, *Phænopora constellata*; *Leptæna transversalis*, *L. subplena*, *Strophomena rhomboidalis*, *S. profunda*, *S. Philomela*, *S. Leda*, *Lingula oblonga*, *L. oblata*, and several other species; *Discina formosa*, *D. tenuilamellata*, *Orthis elegantula*, *O. porcata*, *O. flabellulum*, *Rhynchonella neglecta*, *Pentamerus ob-*

longus, *Stricklandia Canadensis*, *Spirifer radiata*, *S. Niagarensis*, *Atrypa reticularis*, *A. plicatella*, *A. obtusiplicata*, *A. nitida*, *A. nodostriata*; *Avicula emacerata*, *A. subplana*; *Platyostoma Niagarensis*, *Platyceras angulatus*; *Orthoceras Brontes*, *O. undulatum*, *O. virgatum*; *Conularia Niagarensis*, and two undetermined species, one of which is eight inches long, and of which only two specimens have been obtained; *Calymene Blumenbachii*, *Dalmanites limulurus*, *Ceraurus insignis*, *Lichas* undetermined, *Ascidaspis* undetermined, *Bumastes Barriensis*, *&c.* Besides these, there are a number of others which have not been determined, and many more quite obscure. I have obtained two or three specimens of *Atrypa reticularis* which are interesting, as showing perfectly the silicified spiral supports for the arms.

SUPERFICIAL GEOLOGY.

Between the Niagara Escarpment at Hamilton and Burlington Bay, the Medina shales are covered with drift deposits. The surface rises gradually to the foot of the Escarpment, which is 125 feet above the lake. The next hundred feet of the ascent (vertical) of the slope is at a somewhat high angle, and the material is largely made up of the *débris* of the adjacent rocks, often concealing the whole of the Medina, and in some places part of the Clinton also.

The valley to the west of Hamilton, in which Dundas is situated, is about eight miles long, and five or six miles wide at its eastern extremity. It has been excavated by an ancient river, and in form is V-shaped, the apex being to the west. Much of it is filled with irregular hillocks and broken ridges, which are often separated from each other by deep ravines or by alluvial flats of considerable width. The ridges are composed of blue and brown clays, sands or gravels, some of which are largely made up of the *débris* of the Hudson River formation, with boulders of Laurentian gneisses, and also some remains of the rocks of the immediate vicinity The eastern portion of the Dundas valley is occupied by an extensive marsh, which is separated from Burlington Bay by the "Burlington Heights," which are 107 feet above the lake, and consist of a narrow sprit which is made up of sand and coarse and fine gravel—being part of a former shore-line. This ends abruptly at the north-western part of the marsh, and between the Heights and the escarpment to the north, there is a deep ravine, through which the streams from the Dundas valley flowed into Burlington Bay till after the cutting of the Desjardins Canal. About six miles east of this ridge, Burlington Bay is separated from Lake Ontario by a low beach about half a mile wide, consisting of sand and pebbles—this being the present lake-shore.

In several places, streams have made large deep gorges, through the escarpment, some of which are more than half a mile long and even 150 to 300 feet deep. The largest of these is known as Spencer's Ravine.

In the history of the superficial geology of this region there are three distinct epochs:—during the first, the original excavation of the Dundas valley, which has an area of nearly forty square miles, took place; the second epoch is that of the deposition of the Erie Clay and the partial filling of the valley; and the third is that of the re-excavation of the valley, and the formation of the lacustrine beaches and terraces.

1. *The original excavation of the valley of Dundas* appears to have been effected by means of the denuding action of a river flowing from the west, forming a deep gorge, which widened regularly as it approached the mouth, the part below the escarpment being eight or nine miles in length, while at the mouth the width was about six miles,—the whole somewhat resembling the Niagara River between the Falls and Lewiston. The sides had generally a straight course, broken occasionally by a secondary excavation in the solid rocks. The escarpment seems to have had a higher elevation than at present, as the erosive effects of the river had swept away the Medina formation to a depth of more than 60 feet below the present level of the lake.

2. *The partial filling of the Valley* by Erie clay was not much under 200 feet in thickness, if it was uniformly deposited, as it has a depth of 80 feet at Dundas, and on some of the higher surroundings it occurs more than 100 feet above the present lake-level, according to Prof. Bell. This clay frequently contains boulders, partly of Laurentian age, and partly Palæozoic. It also overlies the Medina shales at Hamilton, and at Burlington Heights is about 60 feet deep, all above, to the level of the lake, having been swept away. The boulders have striated the surface rocks of the Niagara formation quite deeply in some places, the direction of these not being constant; just south of Hamilton they are S. 55° W. This epoch was one of subsidence.

3. *The re-excavation of the Dundas valley*, and the recession of the lake were gradual, as the old shore lines are met with at several different heights. The material of which these old water margins are composed is the *débris* of the Hudson River Formation, which occurs on the north side of the lake, together with some boulders and pebbles of Laurentian age, as well as some material from the Niagara formation; the pebbles of the last being more or less angular, while those of the Hudson River formation are generally oval, and contain numerous fossils, among the more common of which are: *Stenopora fibrosa*; *Lingulæ*, *Leptæna sericea*, *Strophomena deltoidea*, *S. nitens*, *Orthis lynx*. *O. occidentalis*, *Rhynchonella recurvirostra*, *Atrypa Headi*; *Modiolopsis modiolaris* and several undescribed species, *Cyrtodonta Hindi ?*, *Ctenodonta*, *Cleidophorus ?* *Avicula demissa*, *Ambonychia radiata*; *Cyrtolites ornatus*, *Murchisonia gracilis*; *Orthoceras crebriseptum*, etc.

During the epoch of the subsidence of the waters of Ontario, the streams emptying by means of the Dundas valley re-excavated the valley, and in the deeper parts carried away all the deposits of the Erie clay, except the lower portion below the lake level. The highest ridge showing the old water margin is just north of Dundas, and has an elevation of more than 300 feet above the present lake level; this consequently conceals the lower members of the escarpment to within a 100 feet of the summit. Gravels and sands occur also on some of the ridges south of the town, at a height of over 100 feet, and coincide in elevation with Burlington Heights. Again the same shore line is exposed in the western part of Hamilton, extending to Hudson Street, where it is no longer seen on the surface; but some distance east it can again be traced, following the same contour lines as those of Burlington Heights, which, as has been stated, are 107 feet above the lake. It consists of alternate strata of sand and of coarse and fine gravel, in some places being cemented into hard rock by infiltrated carbonate of lime. Among these shore deposits there is very little of the *débris* of the Niagara formation.

The high and narrow ridge which constitutes the "Heights" was probably caused by the currents of the river flowing from the Dundas valley meeting the waves of the lake beating in the opposite direction; and consequently the coarser materials carried down by the river were deposited along with the boulders, gravels, and sands, from the lake, in the more quiet waters, where the opposite currents of the river and lake met.

The ridge of Burlington Heights is not a moraine caused by the deposition of boulders and pebbles carried down the valley by glaciers and field-ice; but the material was brought from the Hudson River deposits on the north side of the lake westward by the waves, or assisted by the action of field-ice drifting on the waters of the lake.

In the excavation through this ridge, during the construction of the Desjardins canal, the antlers of a wapiti (*Cervus Canadensis*) and the jaw of a beaver (*Castor fiber*) were obtained at a height of 77 feet above the lake, while seven feet below, several bones of the mammoth (*Euelephas Jacksoni*) were found.

Farther eastward is the Burlington Beach, the present lake shore, separating the bay of that name from Lake Ontario. This consists of a sand-bar, half a mile wide, extending across the bay, with an opening for the discharge of the waters into the lake, by means of the Burlington canal, which is the enlargement of a former outlet. The pebbles of the gravel are not usually large, and consist mostly of oval Hudson River fragments, together with small ones of Laurentian age.

The streams flowing down tributary ravines, which in several places are deeply cut into the Niagara escarpment, have swept away any of the deposits of Erie clay which may have filled them at a former time. The erosive action did not cease when it had formed the beds of the streams, but is constantly wearing away the soft Medina and Clinton shales, and allowing the harder dolomites of the Niagara to fall, so that the beds of the streams are strewn with masses of rock, the largest of which would probably weigh as much as fifty tons. In some of the gorges calcareous tufas are being formed, and in places mosses, leaves, and fragments of wood are being calcified. Some of the tufa beds have attained a thickness of no less than from one and a half to two feet.

From the different water-margins which exist so much above the present lake shore, it is evident that there has been a gradual recession of the waters, due either to a subsidence of the lake from a deepening of its outlet, or to an elevation of the land. The evidence obtained goes to show that it is due chiefly to the latter cause. During the deposition of the Erie clay, the land must have subsided about 400 feet, and the subsequent re-elevation appears to have been about 300 feet.

Minerals.

A few minerals can be obtained in the neighborhood of Hamilton. They are not rare species, but still are not without interest. In the thick five-foot magnesian limestone band of the Niagara formation, there are geodes lined with calcite (dog-tooth spar), barite, celestite, selenite, granular gypsum and pyrite; and often the cavities are filled with highly saline waters. Besides these, quartz crystals, chalcedony, galena, blende and sulphur have been found.

Near the junction of the ravines from Webster's and Spencer's Falls, there is a locality where an efflorescence of the following composition is found:

Magnesium sulphate	61.450
Calcium carbonate	19.532
Ferrous carbonate	12.850
Calcium silicate	2.741
Silica	3.427
	100.000

It is evidently the result of the decomposition of pyrites in presence of dolomite.

Mineral waters—both saline and sulphuretted waters—occur in numerous localities. Of the latter class may be mentioned several springs near the Albion Mills, five miles east of Hamilton, which give off large volumes of gas.

MISCELLANEOUS.

Capture of an enormous Cuttle-fish off Boffin Island, on the Coast of Connemara—On Monday last the crew of a curragh,* consisting of three men, met with a strange adventure north-west of Boffin Island, Connemara. The capture of a cuttle-fish sounds little of an exploit. Ordinarily the fish is of small size, a few inches in circumference, with projecting arms, studded with suckers, by which it retains its prey — the body containing a dark fluid, which it emits on being startled, and, blackening the surrounding water, so eludes its enemy. Very different indeed from this ordinary type was the creature in question. Having shot their spillets (or long lines) in the morning, the crew of the curragh observed to seaward a great floating mass surrounded by gulls; they pulled out, believing it to be a wreck, but, to their great astonishment, found it to be a cuttle-fish, of enormous proportions, and lying perfectly still, as if basking on the surface of the water. What rarely enough occurs, there was no gaff or spare rope, and a knife was the only weapon aboard. The cuttle is much prized as bait for coarse fish, and, their wonder somewhat over, the crew resolved to secure at least a portion of the prize. Considering the great size of the monster, and knowing the crushing and holding powers of the arms, open hostility could not be resorted to, and the fishermen shaped their tactics differently. Paddling up with caution, a single arm was suddenly seized and lopped off. The cuttle, hitherto at rest, became dangerously active now, and set out to sea at full speed in a cloud of spray, rushing through the water at a tremendous rate. The canoe immediately gave chase, and was up again with the enemy after three-quarters of a mile. Hanging on rear of the fish, a single arm was attacked in turn, while it took all the skill of the men to keep out of the deadly clutch of the suckers. The battle thus continued for two hours, and while direct conflict was avoided, the animal was gradually being deprived of its offensive weapons. Five miles out on the open Atlantic, in their frail canvas craft, the bowman still slashed away, holding on boldly by the stranger, and steadily cutting down his powers. By this time the prize was partially subdued, and the curragh closed in fairly with the monster. The polished sides of the canoe afforded slender means of grasp, and such as remained of the ten great arms slashed round through air and water in most dangerous but unavailing fashion. The trunk of the fish lay alongside, fully as long as the canoe, while, in its extremity, the mutilated animal emitted successive jets of fluid which darkened the sea for fathoms round. The head at last was severed from the body, which was unmanagable from its great weight, and sank like lead to the bottom of the sea. The remaining portions were stowed away and carried ashore, to the utter amazement of the islanders. To quote from 'The Sea and its Living Wonders,' I find it stated that—"Near Van Dieman's Land, Peron saw a sepia as big as a tun rolling about in the waters; its enormous arms had the appearance of snakes. Each of these organs was at least seven feet long, and measured seven or eight inches round the base. These well-authenticated proportions are truly formidable, and fully justify the dread abhorrence Polynesian divers entertain of these snake-armed monsters of the deep. Banks and Solander, in Cook's first voyage, found the dead carcase of a gigantic cuttlefish floating at Cape Horn. It was surrounded by aquatic birds feeding on the remains. From the parts of this specimen preserved in the Hunterian Collection, and which have always strongly excited the attention of naturalists, it must have measured at least six feet from end of tail to end of tentacles." If the specimens alluded to above are correctly described as "gigantic" and "formidable," well may the capture made at Boffin be regarded as wonderful; and it is owing to the merest chance that the writer became aware of the circumstance, and possessed himself of such evidence as puts the truth of the matter beyond all doubt. Of the portions of the mollusk taken ashore two of the great arms are intact, and measure eight feet each in length and fifteen inches round the base. The two tentacles attain a length of thirty feet. The mandibles are about four inches across, hooked just like the beak of an enormous parrot, with a very curious tongue. The head, devoid of all appendages, weighed about six stone, and the eyes were about fifteen inches in diameter. Doubtless this account may sound exaggerated, but I hold such portions of the fish as are fully sufficient to establish its enormous size, and verify the dimensions above given.—*Thomas O'Connor, Sergeant, Royal Irish Constabulary; Boffin Island, Connemara, April* 28, 1875.—From *The Zoologist*, June, 1875.

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* These boats are a large kind of coracle made with wooden ribs, and covered with tarred canvas.

FREAKS OF THE DANUBE.—The disappearance of the Danube between Morhingen and Immindingen, on the frontier of the Duchies of Baden and Wurtemburg, is a curious natural phenomenon. For at least half-a-century it has been noticed that some portion of the water of the river flowed into cavities in the calcareous rocks—Jura limestone—to re-appear again near the town of Aach in the Hobgau; now the whole body of water disappears in the vast cavities which have been formed.—*Athenæum.*

EXTINCT WOMBAT.—Among some fossils recently described by Prof. M'Coy, of Melbourne, is an extinct wombat, from the gold-drifts of Victoria. This fossil, called *Phascolomys pliocenus* is of much interest, as having enabled Prof. M'Coy to show that the auriferous deposits whence it was derived, instead of being merely "alluvial," should be referred to the more ancient Pliocene period, thus corresponding in age with the gold-drifts of the Urals.—*Ibid.*

RAT *versus* OCTOPUS.—The aquarium of the Zoological Station at Naples was, last autumn, attacked by a great number of rats, which not only did considerable mischief to the wood work but even caught and devoured a number of the animals kept in the tanks. In an attack on an octopus, however, one of these depredators got by far the worst of the battle, as next morning nothing remained of the four-footed gourmand but the bones and a part of the skin. Though this achievement cannot be compared to the exploits related by M. Victor Hugo, it is interesting as showing that even in captivity a healthy cuttle-fish is well able to take care of itself.—*Ibid.*

BOTANICAL LITERATURE.—The literature of botany, like all other branches of science, is becoming so extensive that the Germans have seen the necessity of publishing an annual record of its progress. Accordingly, a *Botanischer Jahresbericht* is now in course of publication, the first volume, which contains a report of all important papers issued during 1873, having been recently completed. The work is edited by Dr. Leopold Just, Professor in the Polytechnic at Carlsruhe, who is assisted by a large staff of contributors.—*Ibid.*

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NOTE.—Volume VII., containing eight numbers, was commenced in 1873, and extends over a period of two years although dated 1875 on the Title page.

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